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A SCINTILLATION COUNTER FOR THE DIAGNOSIS AND LOCALIZATION OF INTRACRANIAL NEOPLASMS*†

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INTRODUCTION

THE selective concentration of certain materials in intracranial neoplasms is the basis of a new method for the localization of brain tumors. By using a radioactive substance the location of the tumor may be identified by detecting a localized area of high radioactivity. This method was first developed by Moore and his associates[10,12,13,14,15] at the University of Minnesota, who injected fluorescein tagged with I^{131} intravenously and then measured the emitted gamma radiation with Geiger counters placed on the outside of the intact skull. Davis *et al.*,[4] using this method, accurately localized the tumor in 91 per cent of 95 proved cases. Selverstone *et al.*[17] used P^{32} and developed a very narrow Geiger counter in the form of a probe. This has to be used internally at the time of craniotomy because P^{32} emits only beta particles which have a range in tissue of only a few millimeters. P^{32} can occasionally be used successfully for the localization of brain tumors through the intact skull by detecting the Bremsstrahlung emitted by the process of beta-ray absorption.[3] More recently, K^{42} has been successfully used although its efficiency has yet to be determined.[18]

All of these methods depend upon the use of a conventional Geiger-Müller counter for the measurement of the emitted radiation. The efficiency of this instrument for the detection of gamma rays is extremely poor, being approximately 0.2 per cent for a thin window Geiger tube. This results in

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a low counting rate, requiring prolonged counting times in order to obtain a reasonable accuracy, since the statistical variations of a number of counts is proportional to the square root of the total number of counts recorded. Davis *et al.* reported that after the injection of 1.1 millicuries of diiodofluorescein and using a mica window Geiger-Müller counter, their counting rate was of the order of magnitude of three to twenty counts per second. This low counting rate required a counting time of three to five minutes for each area counted in order to obtain any reasonable statistical accuracy. Considering that thirty-two positions over the skull are usually counted, the time for the procedure runs from ninety to 160 minutes.

Consequently, a project was undertaken in our laboratory to attempt the development of an improved method for the detection of gamma rays in order to reduce the time involved in this method of brain tumor localization and to reduce the amount of radioactive material injected into the patient. The instrument most commonly used for the detection of ionizing radiation is the Geiger-Müller counter. Unfortunately, the efficiency* of this detector for gamma rays is very low. A photon or gamma ray is detected only if it produces an electron within the sensitive volume of the Geiger counter. The probability for a photon to produce a secondary electron in the gas of the Geiger tube is very low compared to that of ejecting it from the walls of the counter. The efficiency of a Geiger counter for the detection of gamma rays will be, therefore, dependent on the absorption of this radiation by the walls of the counter. This absorption will take place by Compton and photoelectric effects (pair production may be neglected since it becomes important only for very high energy photons, which are seldom emitted by long lived artificial radio elements) and therefore will be strongly dependent on the atomic number of the absorbing material. Consequently, the efficiency of a Geiger counter for the detection of gamma rays will be greatly improved by coating its walls with a high atomic number element. Thus, a Geiger tube with a copper cathode is more efficient than the conventional tube and a tube with a platinum cathode is four times more efficient than one with a copper cathode.[5] A bismuth-coated cathode tube was tried in this laboratory which resulted in a counting rate of about fifty counts per second in normal patients after the injection of 1 millicurie of diiodofluorescein. Although this constituted an improvement of five to ten times over the mica window counter, an even greater efficiency was considered desirable. This led to the consideration of a scintillation counter.

* In this paper, the word efficiency when used in connection with a radiation detector will refer to the ratio of the number of particles or rays counted to the total number of particles or rays traversing the sensitive volume of the detector.

SCINTILLATION COUNTER VERSUS GEIGER COUNTER

The scintillation counter is based on the property possessed by certain crystals and liquids to emit flashes of light or scintillation when struck by ionizing radiations. This phenomenon was known very early in the field of nuclear physics. Rutherford and his co-workers used an instrument composed of a microscope and a screen covered with zinc sulfide for the detection of alpha rays. The alpha particles impinging on the screen produced scintillations which were observed through the microscope. This method of detecting and counting particles was quite tedious and could be used only for alpha rays since the flashes of light produced by beta and gamma rays were too weak to be observed by the human eye. The development of photomultiplier tubes opened a new field for this method of detecting ionizing radiations. The photomultiplier tube is an extremely sensitive light detector. It is essentially composed of an evacuated envelope containing a photosensitive screen, a series of electron multiplying surfaces or dynodes

and a collector. When light strikes the photosensitive surface, electrons are emitted. These electrons are accelerated by an electric field between the photo screen and the first dynode. Each electron striking the surface of the first dynode knocks out several electrons from this surface. These electrons are accelerated between the first and the second dynode and this phenomenon is repeated at each successive dynode. Finally, the avalanche of electrons is collected by the collector and is recorded as an electric current. In this manner, a flash of light or scintillation will be detected as an electric pulse.

The use of a photomultiplier tube in connection with a scintillating crystal permitted the detection of not only alpha particles but also beta and gamma rays.[2,9] It was soon discovered that many organic as well as inorganic crystals possessed the property of scintillation under the action of ionizing radiations. Among those, anthracene, naphthalene, stilbene, potassium and sodium iodides with a small amount of thallium added, cadmium and calcium tungstates were successfully used. Recently, some organic liquids were found to be good scintillators.

The scintillation counter does not present many advantages over the Geiger counter for the detection of beta and alpha rays, since the latter is nearly 100 per cent efficient for the detection of these particles; however, the scintillation counter is much more efficient for the detection of gamma rays. This is due to the fact that the efficiency of a scintillation counter depends upon the probability that a gamma ray will be absorbed by the crystal and on the probability that the resultant flash of light will reach the photocathode of the photomultiplier tube. These two probabilities may be rendered quite high by using large, clear crystals composed of elements having a high atomic number. An average scintillation counter will be 50 to 100 times more efficient than a thin window Geiger counter for the detection of gamma rays in the energy range between 50 to 2,000 kilovolts. However, the use of this type of a counter for gamma-ray detection has heretofore been limited because of its notorious instability, since large variations in the counting rate may result from minor fluctuations in the surrounding magnetic field or in the high voltage supplied to the photomultiplier tube. We feel that this objection has been satisfactorily overcome in the instrument described below as pertaining to this particular problem of brain tumor localization.

THE SCINTILLATING CRYSTAL

The choice of the scintillating crystal is the determining factor in the efficiency of the detector. Organic crystals such as anthracene and naphthalene were not deemed satisfactory for this project because of their low average atomic number and consequent lower absorption coefficient as compared to inorganic crystals. Although inorganic crystals produce longer pulses, this was not a disadvantage in this particular project. Among the inorganic crystals, calcium tungstate[11] and sodium iodide (with a small added thallium impurity)[7] were thought to have the best potentialities since they both are quite transparent to their own scintillations and have a high density. Since the density of $CaWO_4$ (6.12 grams per cubic centimeter) is much higher than that of NaI(Tl) (3.67 grams per cubic centimeter), it would seem, on the basis of these figures alone, that $CaWO_4$ should be a better phosphor than NaI(Tl) because of its higher absorption of gamma rays. However, another factor should be taken into account in the selection of a scintillating crystal, *i.e.*, the intensity of the light pulses it emits when struck by an ionizing radiation. Low intensity light pulses will produce small electric pulses in the photomultiplier tube, and will therefore reduce the signal to noise ratio, which is an important consideration in scintillation counting. Pulses produced by $CaWO_4$ are much lower than that of NaI(Tl). It appears that in spite of its high density, $CaWO_4$ is a poorer phosphor than NaI(Tl).

This was verified experimentally in this laboratory by comparing crystals of sodium iodide and calcium tungstate, in a scintillation counter. With a background of fifty counts per second, the counting rate obtained with sodium iodide was about twenty times higher than that obtained with calcium tungstate. Thus, it is our opinion that sodium iodide crystals are definitely superior to calcium tungstate crystals for gamma-ray detection despite the greater density of the latter. Unfortunately, sodium iodide is hygroscopic and must be isolated from the air. The crystal used in the instrument described is a single clear NaI(Tl) crystal of cylindrical shape. The cylinder has a diameter of 4 centimeters and is 2 centimeters high. The crystal is protected from air by a thin coating of "plexiglas." A method developed in this laboratory for embedding sodium iodide crystals in "plexiglas" will be described elsewhere.

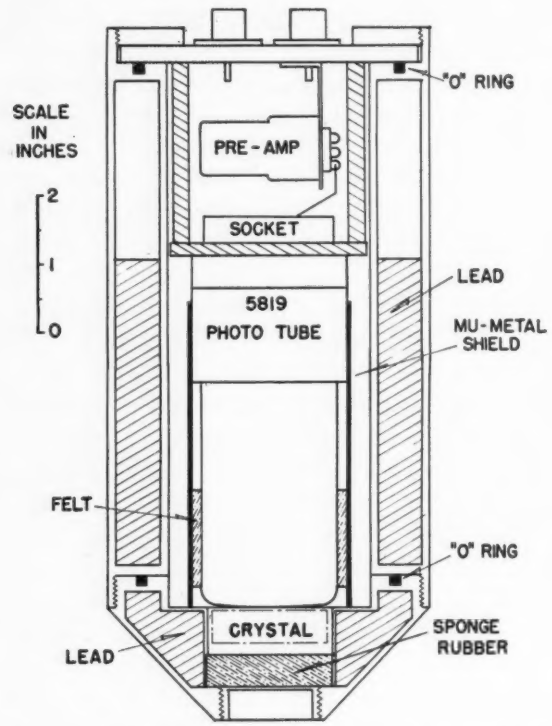

FIG. 1. Cross-section view of the detector head showing the disposition of the preamplifier, phototube, and crystal. The head is constructed of chromium plated brass. The crystal and the photomultiplier tube are shielded with lead as shown in the figure.

THE DETECTOR HEAD

The detector head contains the scintillating crystal, the photomultiplier tube, and the cathode follower. The photomultiplier tube selected for this project was an R.C.A. 5819, (new type). The particular tube chosen for the detector was selected from four of such tubes for its low background noise. These elements are housed in a light tight shielded container (Fig. 1). The photomultiplier itself is protected against outside magnetic fields by means of a "mumetal" magnetic shield.* This precaution is indispensable since the 5819 photomultiplier tube is very sensitive to magnetic fields. A significant change in counting rate may be observed if an unshielded photomultiplier tube is brought from the horizontal to the vertical position. This phenomenon is due to the difference between the horizontal and vertical components of the earth magnetic field. This sensitivity to magnetic fields is practically suppressed by the use of an adequate magnetic shield. The crystal is firmly held against the photocathode of the tube by means of a cushion of foam rubber.

THE STAND

The detector head is suspended on a counterbalanced arm (Fig. 2) which is articulated to allow easy positioning of the detector in any position on the head of the patient (Fig. 3). A series of magnetic clutches are placed on the articulations of the supporting arm and energized through a switch placed near the detector head to allow the operator to "lock" the detector in any desired position. This feature was found to be quite useful in the accurate positioning of the detector on the head of the patient.

* James Millen Manufacturing Company, 150 Exchange Street, Malden, Massachusetts.

THE ELECTRONIC EQUIPMENT

A block diagram of the electronic components is shown on Figure 4. The electric pulses produced by the photomultiplier tube are amplified by a preamplifier contained in the detector head. They are then fed into the main electronic circuit which is shown on Figure 3. This circuit is composed of several units mounted on the same chassis. The electric pulses coming from the preamplifier are further amplified in the linear amplifier and fed to a discriminator which suppresses all the pulses below a given level. An integrating circuit transforms them into a direct current, the voltage of the output of the integrator being proportional to the number of counts recorded by the photomultiplier tube. This counting rate is graphically recorded by an Esterline Angus chart recorder. The electronic circuit also contains a high voltage supply which furnishes the power to the photomultiplier tube. The latter is usually operated around 1,000 volts. The high voltage must be very well regulated since the slightest variation of this voltage will change appreciably the counting rate of the instrument. The electronic equipment described was developed and built in our laboratory since no commercially available instruments were considered adequate for our purpose.

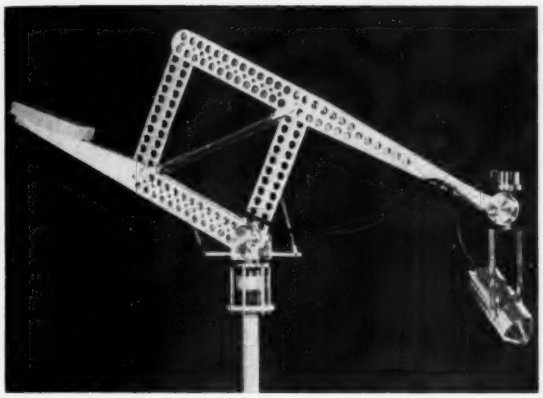

FIG. 2. Counterbalanced arm and detector head. This structure is made of duraluminum for lightness and is mounted on a movable platform to facilitate positioning. Rapid movement is limited by springs. The assembly can be locked in any given position by a series of magnetic clutches.

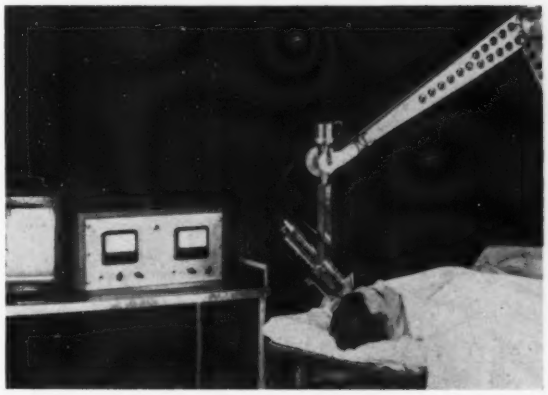

FIG. 3. The scintillation counter as it is used on a patient. The electronic unit and the Esterline-Angus recorder are shown to the left of the detector head.

PERFORMANCE OF THE INSTRUMENT

The efficiency of the scintillation counter for the detection of gamma rays from I^{131} was determined by placing a 1 millicurie source of I^{131} at 1 meter from the detector and recording the counting rate thus obtained (1,280 counts per second). Taking into account the solid angle subtended by the detector, its efficiency was found to be 54 per cent. This efficiency was compared to that of a bismuth-coated cathode Geiger counter.* The Geiger counter was shielded by a tubular lead shield,† 1.2

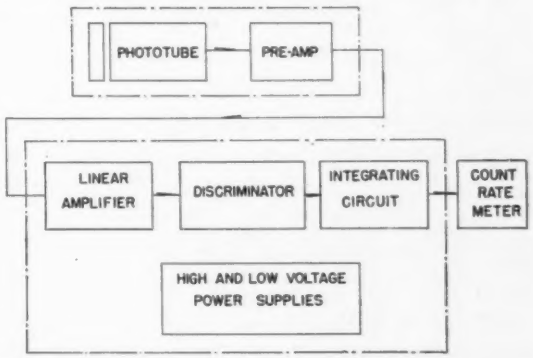

FIG. 4. Block diagram of the electronic unit used in conjunction with the scintillation counter.

* R.C.L. Mark I, Model 13, Dimensions 1½ by 3½ inches.
† Tracerlab, Type P-7.

cm. thick, with an inside diameter of about 4.3 centimeters. The "head" of the counter was recessed about 1.4 centimeters from the open end of the shield. The open end of each instrument was brought (in succession) in contact with the wall of a spherical flask containing 2 liters of water in which about 0.02 millicurie of I^{131} was dissolved. This amount of iodine was previously determined to give (using the bismuth-coated Geiger counter) a counting rate of approximately fifty counts per second, which is approximately the counting rate recorded over the temporal area of a normal brain after the injection of 1 millicurie of radio-diiodofluorescein. Under these conditions, the scintillation counter registered a counting rate forty times higher than the bismuth-coated cathode Geiger tube. No effort was made to normalize these figures to a given solid angle. It can be seen from Figure 1 that the solid angle subtended by the scintillation counter is smaller than that seen by the Geiger tube. It is therefore safe to assume that the efficiency of the scintillation counter is approximately forty times that of the bismuth-coated cathode Geiger counter. The stability of the instrument was tested by recording graphically the counting rate of the instrument with a standard source placed at a fixed distance. No appreciable variation could be observed over a period of several hours.

TECHNIQUE

Before each localization procedure the scintillation counter is standardized by introducing a small radium source embedded in a plastic plug into the cup forming the head of the instrument. The voltage on the dynodes of the photomultiplier is then adjusted to give a standard counting rate. This calibration is necessary since the counting rate of the instrument is strongly dependent on the voltage between the dynodes, and the reading of the voltmeter cannot be relied upon for this adjustment.

The amount of dye injected intravenously for clinical work is 0.25 millicurie of radio-diiodofluorescein. The counting rate observed at the F-7* position on the skull of a "normal" patient twenty minutes after injection of the dye is about 1,000 counts per second with a background of twenty-four counts per second. An interval of about ten seconds of actual counting per point is required. The total time for survey covering a total of thirty-two positions on the skull of a patient is fifteen minutes, not including the fifteen to twenty minute interval after the injection of the dye required for equilibration.

CONCLUSIONS

1. A scintillation counter designed for the detection and localization of brain tumors has been described.

2. The efficiency of this instrument for the detection of gamma rays from I^{131} is about two hundred times greater than that of the conventional thin window Geiger-Müller counter, and about forty times that of a Geiger counter with a bismuth-coated cathode.

3. The increased efficiency of this instrument has reduced the time of brain tumor localization surveys from two to three hours to twenty to thirty minutes.

4. The amount of radioactive material required has been reduced by a factor of four since counting rates of six hundred to seven hundred counts per second are obtained after the injection of 0.25 millicurie of diiodofluorescein.

5. The instrument has been found to be quite stable and reliable.

ADDENDUM

A recent report by Belcher and Evans[1] described a scintillation counter for brain tumor localization, using a thallium-activated potassium iodide crystal. Their counter gave a counting rate of seventy-two counts per second at 1 meter from a 1 millicurie source of I^{131} as compared to a counting rate of 1,280 counts per second obtained by the above described instrument under similar conditions.

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DISCUSSION

Kenneth E. Corrigan, Ph.D. Detroit, Michigan. The presentation by Dr. Ter-Pogossian and his group sets a milestone in one of the most important developments in progress at the present time. A smoothly operating, rapidly adjustable precision instrument for accurate localization of intracranial lesions is certainly a great contribution to the solution of one of the most difficult problems in roentgenological and neurological diagnosis. Recently extensive efforts in this same direction have been made in many large institutions.

The present authors are to be congratulated for their originality in that they did not blindly accept the idea of a high density crystal, for example, but instead did careful precision work to determine the best crystal. The entire presentation reflects careful attention to scientific detail throughout.

The virtues of the scintillation counter per se, and particularly the fact that it is "one hundred times as efficient" as the Geiger counter, have already been well publicized. It must be remembered, however, that this "efficiency" applies to the non-tumor activity of the general background count as well as to the count originating from the tumor. The true over-all efficiency of the scintillation counter for differentiating a small, or weak localization, is not nearly so great as the factor of one hundred might lead one to believe. Mechanical equipment for scanning a part of the body in one plane has an immediate appeal, since the machine does all of the work and such equipment lends itself to relatively inexpensive operation by a technician. Accuracy of localization, however, depends to a certain degree on flexibility, and precision localizations of a quality to be of any real value to a surgeon depend upon ease of operation of the equipment under the manual control of a skilled professional operator.

It is extremely important for the roentgenologist to realize that in the field of isotope diagnosis, which is only now emerging from the chrysalis of fundamental research, he is seeing again the history of the development of roentgenology, only this time seeing it on an accelerated time scale. As little as ten years ago the people attempting to do practical tracer, or "radioactive indicator" studies, were in the position of the skiographer of fifty years ago who could count on nothing more than a small

room not wanted by anyone else and an opportunity to conduct his work at his own expense, after performing whatever useful function he was alleged to perform for the institution. We have now rapidly advanced to the era which had its counterpart in the roentgenology of the late 1920s, and we might name this "the era of the colossal gadgets."

Many here present will remember the 1,000 milliampere chest machine, and similar ponderous mechanical mastodons of that period. That much good came out of this era is attested by the fact that we still have with us the laminagraph and the high voltage roentgen therapy machine, yet no roentgenologist would establish a department based on one of these machines, to rephrase a cliché of that same era, "the machine with the slot on it where the diagnosis comes out has not yet been built."

Just as in that era many people were led to believe that all they needed to do was to buy the machine to do roentgenology, so in the current era many believe that one must only buy a Geiger counter, or a more colossal gadget of the same nature, and isotope diagnosis will come forth from the machine.

In a working department of roentgenology, which is where isotope diagnosis belongs, the isotope laboratory is a powerful supplement to established methods. Inevitably, therefore, the isotope laboratory gets those cases which have been thoroughly studied by other departments, including the regular diagnostic roentgen department, often without satisfactory results.

In the case of intracranial lesions, this means that the isotope laboratory, in addition to getting a few brain tumors which are relatively easy to localize, will also get the cases with nonspecific generalized inflammation of the cerebral cortex, with extradural tumors and with piaglial scars, none of which give the type of localization to be expected from a tumor. It is therefore imperative, if anything is to be accomplished, that both the equipment and the operator be capable of establishing a negative localization as well as a positive one. The isotope group will hardly ever be called upon to establish straight-forward intracerebral lesions which have definite neurological localizations and good roentgen findings, yet the localizations that the isotope laboratory can make and does make routinely in a large institution is a matter of life and death to a significant number of patients.

Roentgenologists should realize, therefore, that, while this new instrumentality brings into their hands a diagnostic method fully as powerful as the roentgen ray itself for some purposes, the major investment which must be made to take advantage of the new medium is more intellectual than financial. A rather simple and comparatively inexpensive instrument will produce excellent and perfectly reliable results, and a beautiful machine like the one shown us by Dr. Ter-Pogossian, requires the services of somebody with his skill to be of any value.

DR. ROBERT R. NEWELL, San Francisco, California. I would like to add my word of enthusiasm for the promise of scintillation counting. I agree with Dr. Corrigan that brains are a necessity. Nevertheless, fine work tools are also a necessity.

Parenthetically, I disagree with Dr. Corrigan. I just love to keep my records in counts per second. Consider the whole brain slightly radioactive, and the tumor not very big and the concentration in the tumor only a few times greater than its surroundings. Here is the crystal and the collimator. You take in a lot of brain as well as tumor. The difference in signal between the place where your collimator is just off the tumor and where it entirely covers the tumor is not a very large percentage difference. If you want to get accuracy, therefore, you have to get a great many counts because the probable error of the difference of two counts is the root square sum of the probable errors of the counts on and off. If the difference is small, in order to get the probable error down to a level that is comparable to the difference itself, you have to make a great many counts, and that is one of the reasons why the scintillation counter is so superior. Because of its high efficiency for gamma rays you can get a large number of counts in a reasonable time and with a reasonable dose of isotope.

Part of this depends upon the efficiency of the collimator. If you could take a collimator which sees only a nice narrow parallel beam and sees nothing outside of that, and could have that just exactly the size of the tumor, then you would have maximum difference between the signal (counting rate) on the tumor and off the tumor. Even then you would have the signal from the tumor diluted with the counts from the brain before and behind the tumor. You find that still the difference (the net tumor sig-

nal) is not very great. In order to get a large number of counts, therefore, you would like to make use of the full size of the crystal, perhaps 5 by 5 cm.

It is obvious that you cannot have a collimated scanning beam any smaller than the size of the face of the crystal. Requiring a narrow beam, one should therefore use a multiple channel collimator, all the channels being pointed toward the tumor (sketched on the blackboard).

Dr. Ter-Pogossian (closing). Dr. Corrigan mentioned the fact that the use of counts per second would be objectionable because of fractional counts. I mentioned the fact that our counting rates were of the order of units of 1,000 counts per second. It is hardly necessary to use a fraction of the count. If we were using counts per minute, we would have to use units as high as 60,000 counts per minute. It seems to me that figures of the order of 1,000 are easier to handle than 60,000.

Concerning the matter of the time taken for scanning a head by means of a Geiger counter, I obtained this figure from the Chicago group. They are using the same window Geiger counter and their time runs around two hours. I have observed one of these diagnostic procedures myself. Dr. Corrigan very probably has a better instrument than the Chicago group. I was unaware of this fact.

THE USE OF SERIAL ANGIOGRAPHY IN THE DIAGNOSIS OF SPACE OCCUPYING INTRACRANIAL LESIONS*

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IT IS almost a quarter of a century since the introduction by Egas Moniz[3] in 1927 of a technique for visualization of cerebral blood vessels. His initial publication emphasized the importance of the new technique in the localization of cerebral tumors. After experimentation with various radiopaque substances, Egas Moniz[4] finally decided on thorotrast as the material of choice. Objections to this substance were numerous and, probably because of this, cerebral angiography was only sporadically carried out in this country for the next decade and a half.

When Gross[7] introduced in 1940 the use of diodrast (sodium iodopyracet), a more satisfactory but not ideal substance was made available. When used in 50 per cent concentration (so-called 35 per cent compound diodrast) visualization is satisfactory. The material is rapidly excreted by the kidneys and, if accidentally extravasated outside the vessel, the resultant local reaction is not serious. It has the disadvantage of occasionally producing an allergic reaction in sensitive individuals and of being moderately irritating to the intima of the blood vessels.

Further reports by Gross[8,9] and other workers followed, and in 1946 List and Hodges[11] reported 136 cases of expanding intracranial lesions studied by carotid or vertebral angiography. Their classic paper sets forth the basic principles of the angiographic diagnosis of space occupying lesions.

Although Loman and Myerson[12] had described the technique of percutaneous injection of the common carotid artery, surgical exposure of the vessels continued to be the method used by most neurosurgeons and is still favored by some. However, the example of Ecker and Chamberlain,[2] Sugar, Holden and Powell[15] and others, has led to the perfection of the percutaneous method of puncture of both the carotid and vertebral arteries until now it is commonplace for many surgeons to carry this out in 90 to 95 per cent of the cases attempted. Culbreth, Walker and Curry[1] have reported successful percutaneous carotid punctures in 92 of 96 patients. Once a surgeon has perfected his ability to carry out percutaneous angiography successfully in a high percentage of cases, his use of the procedure naturally increases. The percutaneous method is more acceptable to the patient, it permits ready repetition, it can be carried out entirely in the roentgen department (a considerable advantage in institutions where surgical schedules are heavy and available time in the operating room is consequently limited), and it facilitates complete intracranial angiography, that is the visualization of both carotid and the vertebral vascular trees. This latter is essential in the localization and evaluation of aneurysms and in the recognition of space occupying lesions which have not given signs referable to one cerebral hemisphere or to the posterior fossa.

Egas Moniz,[3,4] as well as later workers, recognized the value of multiple or serial films, especially in the diagnosis of intracranial tumors. Various methods of plate changing, both manual and automatic have been developed, and first Holm[10] and recently Gass, Weinberg, Craig, Thompson and Dreisinger[6] have developed cinefluorographic methods of cerebral angiography. Raney, Raney and Sanchez-Perez[14] have emphasized the value of serial angiography in revealing rapid blood passage because of short circuiting in arteriovenous communications and retarded blood flow due to impending circulatory failure of the involved

* From Mercy Hospital-Loyola University Clinics, Chicago, Illinois.

hemisphere in tumors. In the latter case, they recommended preliminary decompression to permit re-establishment of the circulation before carrying out a radical attack on the tumor. Lusignan and Cross[13] have reported a case of calcified intracerebral hematoma that displaced the veins but not the arteries in a lateral angiogram. This further indicates the importance of depicting the venous as well as the arterial supply of the brain in diagnostic angiograms.

The present report deals with some examples of serial carotid and vertebral angiography in the diagnosis and localization of space occupying lesions. Except where otherwise stated, the injections were made by the percutaneous technique and consisted of two or more injections of 10 cc. of 35 per cent compound diodrast made as rapidly as possible through an 18 gauge needle. When the injection was about one-fourth completed the technician was signalled to start the seriograph (Sanchez-Perez) and a series of six films were exposed during the next four and a half seconds. Usually a set each of anteroposterior and lateral exposures was made for each carotid or vertebral injection. On occasion in the search for the source of subarachnoid hemorrhage, six such injections have been made at one sitting, visualizing both carotid and the vertebral vascular trees with anteroposterior and lateral sets of films in each case. The procedure was carried out under local infiltration of the skin and soft tissues with 1 per cent procaine. All the patients had a preliminary test for sensitization to diodrast and all received nembutal, 0.3 gm., sixty to ninety minutes before the procedure. No generalized convulsions occurred; a few patients showed abortive clonic seizures of the extremities contralateral to the side of the injection.

Angiography has certain advantages over air studies (ventriculography or encephalography) in the diagnosis and localization of space occupying lesions. First and most important is its relative safety. While intracranial angiography with diodrast carries some risk of vascular complication in the elderly arteriosclerotic patient there have been no complications reported due to its use in patients with increased intracranial pressure. The risk of air injections in this group of patients is well known. A second advantage of angiography is its relative lack of discomfort. Aside from the momentary discomfort of the injection and the local pain in the neck after the procedure, there is no discomfort connected with angiography. The prolonged discomfort suffered by many patients after air studies, especially pneumoencephalography, is well known. More exact localization of a neoplasm is often possible in an angiogram than in an encephalogram or ventriculogram. The preoperative pathologic diagnosis of an intracranial tumor is rarely, if ever, possible from air studies, but the vascular pattern of a neoplasm often makes it possible to correctly diagnose its pathologic nature. Finally, and of great importance from the surgical standpoint, a knowledge of the arterial supply and venous drainage of a neoplasm is invaluable in planning and executing a surgical procedure.

The following cases illustrate the use of serial angiography in the diagnosis and localization of space occupying intracranial lesions.

REPORT OF CASES

Case 1. E.P., male, aged twenty-eight, was first seen April 9, 1949. Eighteen months previously he had had an attack of numbness of the right leg followed by loss of consciousness. For six months he had had seizures which began as paresthesias in the right thigh. Clonic jerking of the right lower extremity progressed to the right upper extremity and then a generalized seizure with loss of consciousness occurred. For three weeks he had suffered from headaches and progressive right hemiparesis.

Examination revealed moderate weakness and incoordination of the right extremities, increase of the tendon reflexes in the right lower extremity, and sustained right ankle clonus. Position sense was lost in the right toes and there was mild hypesthesia to pin prick and

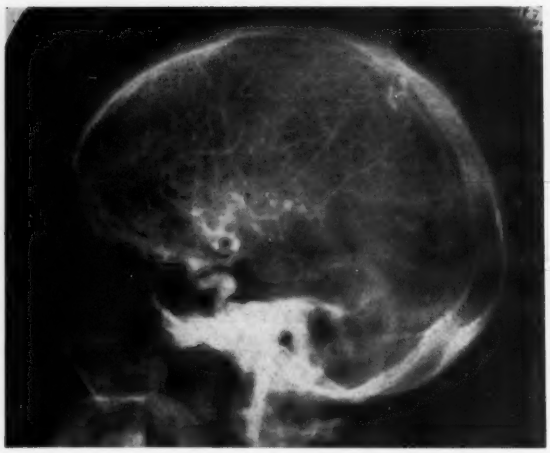

Fig. 1. Case 1. Left carotid angiogram. Film 1 of lateral series. There is increased vascularity in the posterosuperior parietal region.

light touch on the right side of the body. There was moderate asterognosis of the right hand and early bilateral papilledema.

Left percutaneous carotid serial angiography was performed. Figures 1 and 2 are numbers 1 and 3 respectively of the lateral series. Figures 3 and 4 are numbers 1 and 5 of the anteroposterior series. The increased vascularity in the posterosuperior parietal region indicates the location of the neoplasm. Its venous drainage is by both superior and mesial cerebral veins. The anteroposterior views show the displacement of the anterior cerebral artery across the midline and that the arterial supply of the lesion is from the anterior cerebral artery and deep branches of the middle cerebral.

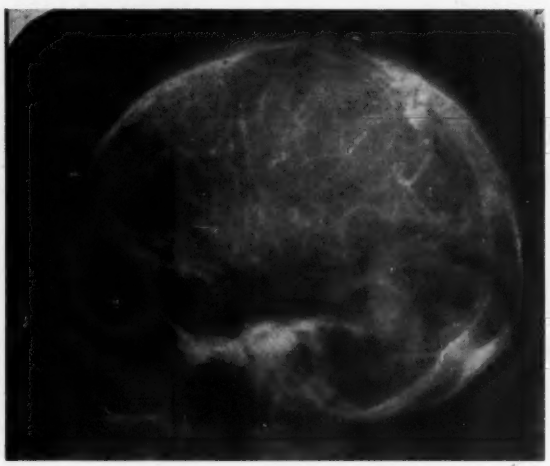

Fig. 2. Case 1. Left carotid angiogram. Film 3 of lateral series. The large veins draining the posterosuperior parietal region can be seen.

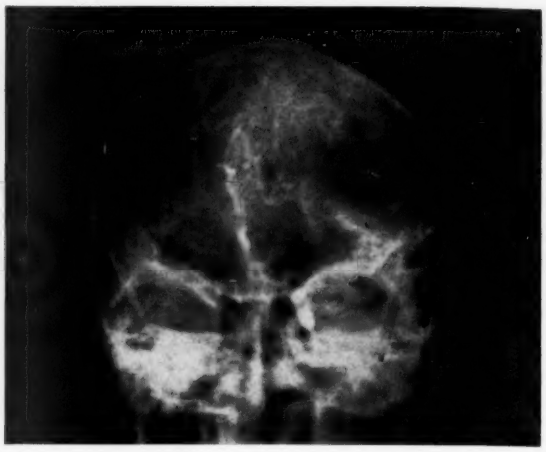

Fig. 3. Case 1. Left carotid angiogram. Film 1 of anteroposterior series. There is marked displacement of the anterior cerebral artery toward the right. The increased vascularity in the superior parietal region is derived from the anterior cerebral and deep branches of the middle cerebral arteries.

Left parietal craniotomy disclosed a subcortical cyst 2 cm. below the surface which contained 60 cc. of deep-yellow fluid. Posterior to the cyst there was an extensive, friable, very vascular infiltrating tumor. Subtotal removal of this was carried out and the wound closed. Microscopic examination of the tissue removed proved it to be a rapidly growing glioblastoma.

The patient was given a course of high voltage roentgen therapy as soon as the wound had healed. Three months later he was seen at his home. He was weak and listless and having frequent seizures in spite of anticonvulsant

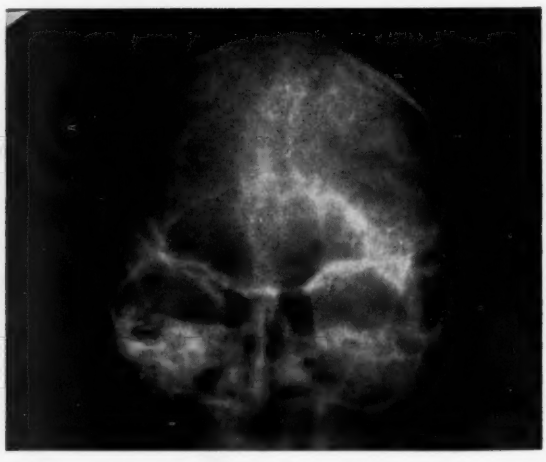

Fig. 4. Case 1. Left carotid angiogram. Film 5 of anteroposterior series. The venous drainage of the superior parietal region is by both superior and mesial cerebral veins.

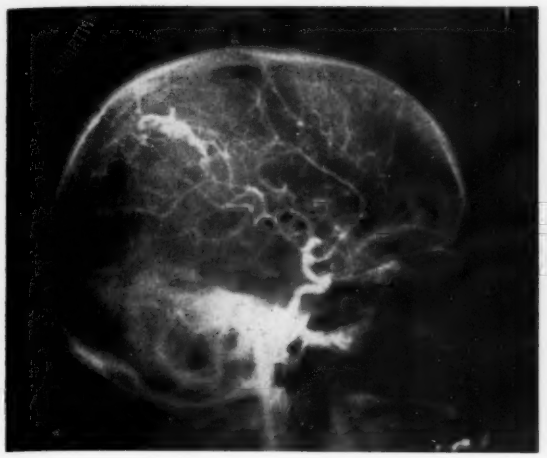

Fig. 5. Case II. Right carotid angiogram. Film 1 of lateral series. There is increased vascularity in the posterior parietal region with early filling of large veins.

medication. There was moderate right hemiparesis and slight aphasia with no papilledema.

Comment. This man in his third decade had a history and neurological findings that indicated a rapidly developing tumor in the left parietal region. Serial carotid angiography substantiated this diagnosis and indicated a highly vascular lesion receiving its blood supply from both the anterior and middle cerebral arteries. Craniotomy revealed a cystic, highly vascular glioblastoma. In spite of subtotal removal and roentgen therapy, there was evidence of considerable progression three months later.

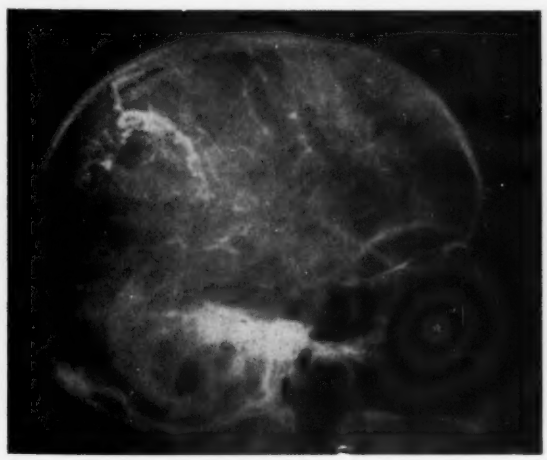

Fig. 6. Case II. Right carotid angiogram. Film 3 of lateral series. There is slow emptying of the large veins in the superior parietal region.

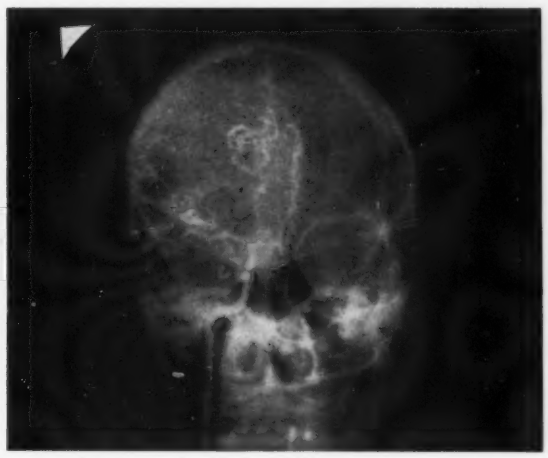

Fig. 7. Case II. Right carotid angiogram. Film 1 of anteroposterior series. The anterior cerebral artery is displaced to the left of the midline and there are large venous channels on the medial aspect of the right cerebral hemisphere.

Case II. F. F., female, aged forty-three, was first seen January 10, 1950. Two months previously she had begun to have right sided headaches with associated nausea and vomiting. For the past month progressive weakness of the left extremities had developed until she had become bedridden.

Examination revealed profound left hemiparesis with asterognosis of the left hand, impairment of position sense in the left fingers and toes, and moderate hypesthesia to pin

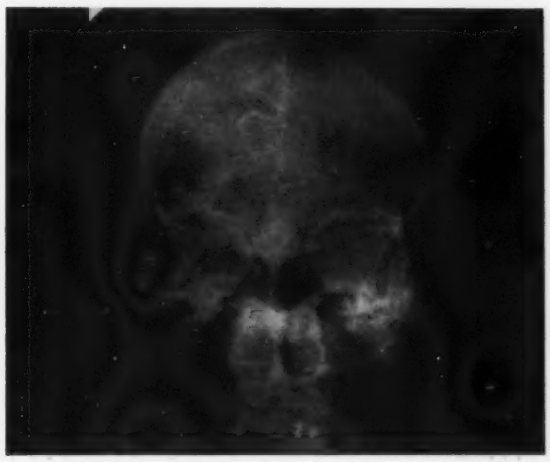

Fig. 8. Case II. Right carotid angiogram. Film 3 of anteroposterior series. The large veins on the mesial aspect of the hemisphere enter both the superior and inferior longitudinal sinuses.

prick and light touch on the left side of the body. There was bilateral papilledema of 3 to 4 diopters with many hemorrhages and exudates. Percutaneous right carotid serial angiography revealed increased vascularity in the posterior parietal region with displacement of the anterior cerebral vessels to the left of the midline. Figures 5 and 6 are films number 1 and 3 of the lateral series, Figures 7 and 8 are films number 1 and 3 of the anteroposterior series. In the anteroposterior films large veins from the tumor are seen to enter the superior and inferior longitudinal sinuses.

Right parietotemporal osteoplastic craniotomy was carried out on January 16, 1950. There was a fairly well demarcated, very vascular, friable, infiltrating neoplasm below the surface in the posterosuperior parietal region. After the parasagittal veins previously demonstrated in the arteriogram had been secured, removal of the tumor was accomplished by a block resection of the posterosuperior part of the parietal lobe.

Microscopic examination of the tissue removed revealed a degenerating glioblastoma. The patient was given a course of high voltage roentgen therapy before dismissal from the hospital. As the papilledema subsided, there was marked pallor of the optic discs.

Eight months later she wrote that she was walking with a cane and was able to use her left arm. She also stated that her vision was much improved.

Comment. A woman in the fifth decade had a history and findings indicative of a tumor of the left parietal lobe. Serial carotid angiography confirmed this and gave valuable information about the vascularity and venous drainage of the neoplasm. On exploration, the tumor proved to be a glioblastoma. It was completely removed from the gross standpoint. Eight months later there was no clinical evidence of recurrence.

Case III. C. F., male, aged thirty-seven, was first seen on July 30, 1950. For two years he had left frontal headache. A roentgenogram of the skull eighteen months before was said to have shown displacement of the pineal to the right. Recently diplopia and slight speech difficulty had appeared.

Neurological examination revealed slight increase in the tendon reflexes on the right with impairment of the right abdominal reflexes. Perimetric fields showed a partial right homonymous hemianopsia. A roentgenogram of the skull showed the pineal body to be calcified and displaced 1.5 cm. to the right of the midline. Left percutaneous carotid serial angiography showed marked upward displacement of the middle cerebral vessels and slight displacement of the anterior cerebral artery to the right of the midline. Figures 9 and 10 are numbers 1 and 6 of the lateral series. In Figure 10 a large posterior anastomatic vein (Labbé's) is seen to drain the middle cerebral or sylvian veins to the lateral sinus. The importance of this vein in the drainage of the patient's left cerebral hemisphere is obvious. Figure 11 is film number 1 of the anteroposterior series. The

Fig. 9. Case III. Left carotid angiogram. Film 1 of lateral series. There is marked upward displacement of the middle cerebral vessels.

Fig. 10. Case III. Left carotid angiogram. Film 6 of lateral series. There is a large posterior anastomatic vein (Labbé's) draining the sylvian vein into the lateral sinus.

angiographic diagnosis was an avascular neoplasm of the posterior part of the left temporal lobe.

Operation on August 14, 1950, revealed a subcortical, firm, avascular, infiltrating neoplasm of the posterior part of the left temporal lobe. Block resection of the posterior half of the left temporal lobe was carried out. The resection extended to the temporal horn of the ventricle. Every effort was made to preserve the large vein that coursed from the posterior part of the sylvian vein to the lateral sinus. However, the marked bulging of the brain when the dura was first opened produced rupture of this vein and it was necessary to clip it. It was then sectioned between clips.

Postoperatively, the patient had right hemiplegia and aphasia. He was given a course of high voltage roentgen therapy. At the time of dismissal from the hospital, he had recovered the use of the right side and his speech was greatly improved. There was complete right homonymous hemianopsia. Most of the microscopic sections made from the tissue removed showed the cellular picture of protoplasmic astrocytoma, but in a few areas the cellular picture was that of a glioblastoma.

Comment. A man in the fourth decade had a history, neurological findings, and roentgenographic findings of a slowly growing neoplasm of the posterior part of the temporal lobe. Carotid serial angiography substantiated the location of the tumor and indicated a lack of vascularity. An important anomalous vein over the left temporal lobe was indicated. At operation the tumor proved more malignant than anticipated and, in spite of our knowledge of the anomalous vein, it was not possible to preserve it.

Fig. 11. Case III. Left carotid angiogram. Film 1 of anteroposterior series. There is only slight displacement of the anterior cerebral artery to the right of the midline.

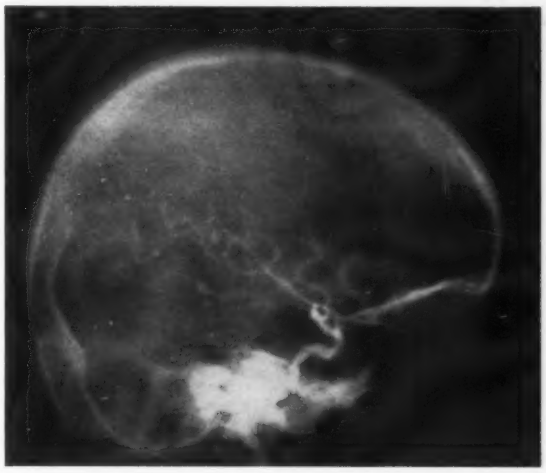

Fig. 12. Case IV. Right carotid angiogram. Film 1 of lateral series. The anterior cerebral artery is not visualized. The proximal part of the middle cerebral artery is displaced downward.

Case IV. H. L., female, aged fifty-one, was first seen August 9, 1949. The preceding two months she had been progressively lethargic, indifferent, and forgetful, with frequent irritability. She was clumsy, frequently dropped things

Fig. 13. Case IV. Right carotid angiogram. Film 2 of lateral series. There is further filling of the middle cerebral vessels. Note the residual air in the anterior horn of the ventricles from the pneumoencephalogram two days before.

and occasionally fell. She slept a great deal and had lost 14 pounds in weight.

Neurological examination was essentially normal except for mental dullness, apathy, and indifference. The optic fundi did not show any evidence of increased intracranial pressure.

Pneumoencephalography was performed. The right lateral ventricle did not fill. There was questionable displacement of the third ventricle to the left of the midline. Right lateral carotid serial angiography was performed two days later. The anterior cerebral artery did not fill in any of the films and the first part of the middle cerebral artery was displaced downward. Figures 12 and 13 are films number 1 and 2 of this lateral series. Residual air in the anterior horns of the ventricles can be seen. Because of technical difficulties an anteroposterior series was not made. The angiographic diagnosis was avascular neoplasm of the right frontal lobe.

Right frontal osteoplastic craniotomy on August 17, 1949, revealed a firm, tough, avascular, subcortical infiltrating neoplasm in the right frontal lobe. Complete removal of the neoplasm was effected from a gross standpoint. Microscopic examination of the tissue showed it to be a protoplasmic astrocytoma. The patient remained stuporous after operation, and three days later had a series of convulsions. She continued to fail and died six days after operation.

Necropsy did not reveal any evidence of postoperative hemorrhage. There was generalized edema of the brain with pressure cones at both the incisura of the tentorium and the foramen magnum. No evidence of neoplasm was found in sections taken from the walls of the operative cavity in the right frontal lobe.

Comment. A woman in her sixth decade showed marked behavior and personality changes for two months. Pneumoencephalography was not diagnostic but suggested right frontal neoplasm. Right carotid serial angiography confirmed this and indicated that the neoplasm was avascular. At operation an avascular astrocytoma of the right frontal lobe was completely removed. The patient did not survive the operation.

Case v. M.A., female, aged forty, was first seen December 3, 1949. Four months previously she had begun to have seizures which started in the right side of the face and progressed to involve the right upper and then the right lower extremities. A few attacks had become generalized with loss of consciousness.

Examination revealed mild right hemiparesis with right hyperreflexia and a right Babinski response. An electroencephalogram showed a focus of abnormal activity in the left posterior parietal region.

On December 19, 1949, left carotid serial angiography was carried out after surgical exposure of the left common carotid artery in the neck. Figure 14 is the first film in the lateral series. The widening of the curve between the anterior and middle cerebral vessels is well seen in spite of the poor filling of these vessels.

Fig. 14. Case v. Left carotid angiogram. Film 1 of lateral series. There is marked widening of the curve between the anterior and middle cerebral vessels. Both of these vessels are poorly filled.

Fig. 15. Case v. Left carotid angiogram. Film 5 of anteroposterior series. There is no displacement of the anterior cerebral vessels.

Figure 15 is film number 5 in the anteroposterior series. It fails to show any dislocation across the midline of the anterior cerebral vessels. Because of this, there was some doubt as to whether the patient actually had a left cerebral tumor, and on December 21, 1949, pneumoencephalography was performed. Figure 16 is the anteroposterior roentgenogram taken after this procedure and shows compression and slight displacement across the midline of the anterior horn of the left lateral ventricle.

Left frontoparietal osteoplastic craniotomy was carried out on December 25, 1949. This revealed a firm, rubbery, subcortical infiltrating mass 3 cm. deep in the left parietal lobe. Because of the location of the mass its removal was not attempted. The operation was completed as a large subtemporal decompression. Microscopic examination of tissue removed by aspiration through a cannula revealed it to be a protoplasmic astrocytoma.

After the wound had healed, the patient was given a course of high voltage roentgen therapy. Eight months later she was having an occasional seizure in spite of anticonvulsant medication. There was no papilledema or bulging of the decompression. Mild right hemiparesis and slight dysarthria persisted.

Comment. A woman, just beginning the fifth decade, had a history, neurological, and electroencephalographic findings of a left parietal lobe tumor. Left carotid serial angiography showed in the lateral views widening of the angle between the middle and anterior cerebral vessels, but there was no displacement of the anterior cerebral vessels across the midline in the anteroposterior views. Pneumoencephalography revealed slight compression and medial shift of the anterior horn of the left lateral ventricle. Craniotomy revealed a subcortical avascular parietal neoplasm which proved to be an astrocytoma. Eight months later the patient was in good general health but with mild neurologic deficit and occasional seizures.

Case vi. E.E., male, aged sixty-one, was first seen on August 18, 1950. He had noted inability to see objects to his right for two weeks. For a week he had had severe occipital headache. Dizziness had been present for two days.

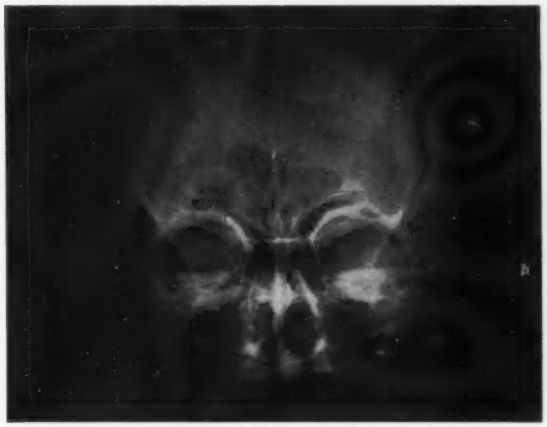

Fig. 16. Case v. Anteroposterior encephalogram. There is compression and slight medial displacement of the anterior horn of the left lateral ventricles.

Examination revealed mild weakness and incoordination of the right upper extremity. The perimetric fields showed a complete left homonymous hemianopsia. Because of the sudden onset and the patient's age it was considered that he probably had a vascular lesion. A pneumoencephalogram was attempted, but although 85 cc. of cerebrospinal fluid was removed by lumbar puncture and air substituted, no air entered the cerebral ventricles. There was moderate distribution of air in the subarachnoid spaces over the right cerebral hemisphere but almost none on the left (Fig. 17). Therefore, percutaneous left carotid serial angiography was performed. Figures 18 and 19

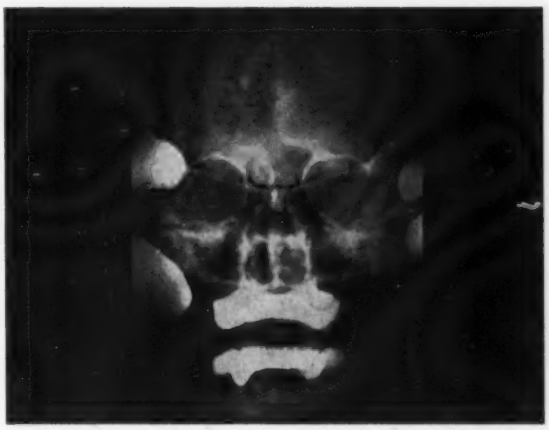

Fig. 17. Case vi. Anteroposterior encephalogram. There is no air in the ventricles. There is a moderate amount of air in the subarachnoid space over the right cerebral hemisphere but almost none on the left.

FIG. 18. Case VI. Left carotid angiogram. Film 3 of lateral series. The posterior communicating artery is visualized. The middle cerebral vessels are displaced upward, especially in their distal portion.

are films 3 and 2 from the lateral and anteroposterior sets of films respectively. In Figure 18 the middle cerebral vessels are seen to be displaced upward. The posterior cerebral artery is visualized but is poorly filled. In Figure 19 the anterior cerebral artery shows minimal displacement to the right of the midline. The angiographic diagnosis was an avascular glioma of the posterior part of the left temporal lobe.

On August 23, 1950, operation was carried out. This revealed an infiltrating subcortical glioma in the posterior part of the left temporal lobe. Subtotal removal of the neoplasm was accomplished but, because of its depth and extent, complete removal was not accomplished. Microscopic examination of the tissue removed showed a protoplasmic astrocytoma.

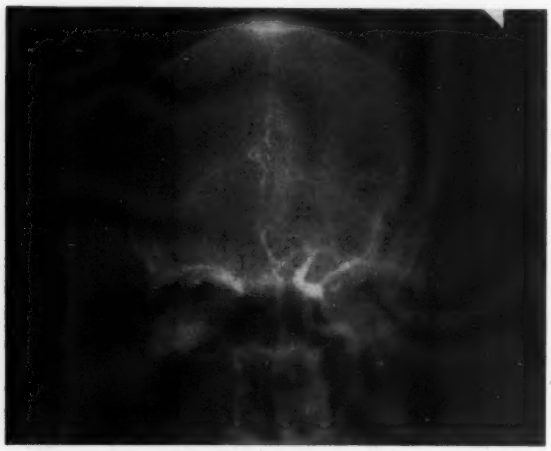

FIG. 19. Case VI. Left carotid angiogram. Film 2 of anteroposterior series. There is very slight displacement of the anterior cerebral artery across the midline.

Immediately following operation there was an aphasia and total right hemiparesis. This rapidly cleared up. The patient was given a course of high voltage roentgen therapy. At the time of dismissal from the hospital he had no neurological findings except complete right homonymous hemianopsia.

Comment. A man beginning the sixth decade had a history of sudden onset of symptoms indicating a lesion in the posterior part of the left temporal lobe. Pneumoencephalography was not diagnostic but carotid serial angiography indicated an avascular neoplasm of the posterior part of the left temporal lobe. Surgical exploration revealed a subcortical protoplasmic astrocytoma of the posterior part of the left temporal lobe. Complete removal was not accomplished.

CASE VII. Mrs. E. F., aged sixty-five, was first seen on August 12, 1949. She had lost her sense of smell for the past two years and there had been progressive personality change with emotional instability, vulgar speech, memory defects, loss of interest in housekeeping, moderate alcoholism, and occasional exhibitionism.

Examination revealed an elevated blood pressure (170/108); moderate retinal arteriosclerosis, and mental dullness with slow responses. There was complete bilateral loss of smell. The spinal fluid pressure was 400 mm. and the total protein content was 251 mg. per cent. Roentgenograms of the skull showed hyperostoses of the floor of the anterior cranial fossa anterior to the sella (Fig. 20). A percutaneous left carotid serial angiogram was made. Because of technical difficulties only an anteroposterior set of films was made. Figure 21 is film number 2 of that series. It is an essentially normal anteroposterior angiogram and it was presumed that the patient had a small basofrontal meningioma which did not displace the anterior cerebral arteries.

A bilateral frontal craniotomy through a coronal scalp incision revealed a large basofrontal meningioma filling the anterior cranial fossa and of equal extent on each side. The tumor was found to involve the anterior part of the circle of Willis. A partial removal was

effected but the patient did not do well after operation and died a week later. At necropsy the remaining portion of the tumor included both anterior cerebral and the posterior communicating arteries and displaced the anterior part of the third ventricle upward, partially blocking it.

Comment. A woman in her seventh decade had a history, neurologic, and roentgenographic findings of a large basofrontal meningioma. Incomplete angiography failed to show any abnormalities or to give any idea of the true extent of the neoplasm.

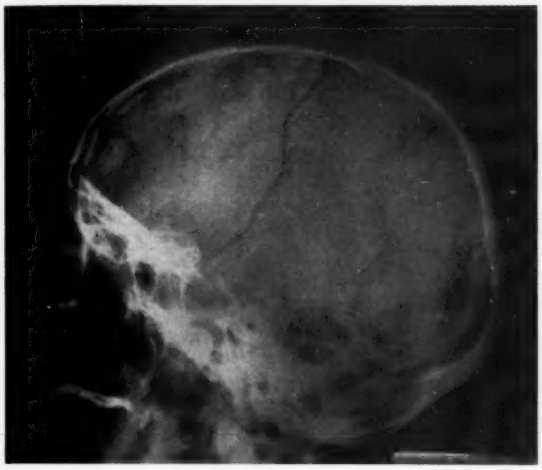

Fig. 20. Case vii. Lateral roentgenogram of the skull. Note the hyperostoses of the floor of the anterior cranial fossa.

A more complete study, at least a left lateral set of films and preferably right carotid angiography as well, would undoubtedly have given valuable information. At operation the tumor was found to include the anterior portion of the circle of Willis. Although complete removal was not attempted the patient did not survive the operation.

Case viii. D. N., female, aged eleven, was first seen April 11, 1950. Her parents had noted the onset of left internal strabismus four months before. At that time the child began to complain of headaches. A month later progressive weakness of the lower extremities began. For a week there had been nausea and vomiting with weakness of the right lower extremity.

Examination revealed a thin dehydrated

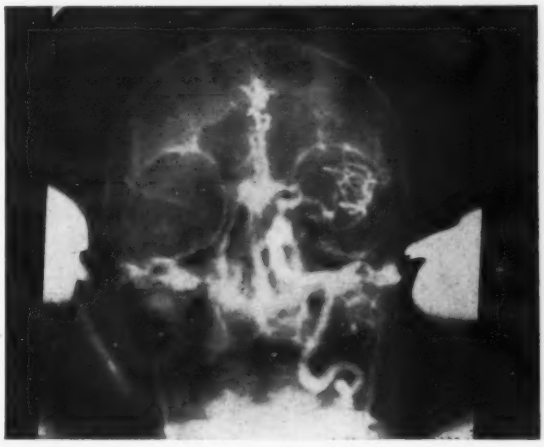

Fig. 21. Case vii. Left carotid angiogram. Film 2 of anteroposterior series. There is no displacement or distortion of the anterior cerebral artery.

child who could not stand alone because of weakness and ataxia. In addition to weakness of both legs, there was weakness of the right upper extremity. The tendon reflexes were increased on the right but there was a left Babinski sign. There was slight nystagmus on either lateral gaze, left abducens palsy and impairment of pupillary reflexes on the right.

An electroencephalogram revealed diffuse slow waves with no evidence of localization. A pneumoencephalogram was attempted. With the patient in the upright position 85 cc. of cerebrospinal fluid was removed and air substituted. Roentgenograms of the skull failed to show any air in the ventricles and only a slight amount in the basilar cisterns. Percutaneous serial vertebral angiography was

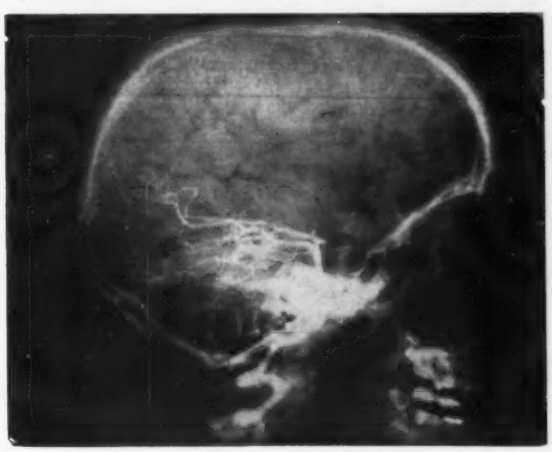

Fig. 22. Case viii. Vertebral angiogram. Film 2 of lateral series. There is anterior displacement of the middle portion of the basilar artery.

carried out. Figure 22 is film number 2 of the lateral series. The basilar artery is seen to be displaced anteriorly, indicating a neoplasm of the brain stem. Since the neurologic findings were compatible with this, surgical exploration was not advised.

The child was given a course of high voltage roentgen therapy to the posterior fossa. Two months later she was able to walk, although right hemiparesis persisted. She had no headache or nausea and had gained 12 pounds in weight.

Comment. A girl in the first part of the second decade had a history and findings suggestive of a glioma of the brain stem. An electroencephalogram and a pneumoencephalogram were not diagnostic. Lateral vertebral serial angiography revealed an anterior displacement of the vertebral artery that was thought to indicate a tumor of the brain stem. Surgery was not advised and roentgen therapy was given with moderate improvement.

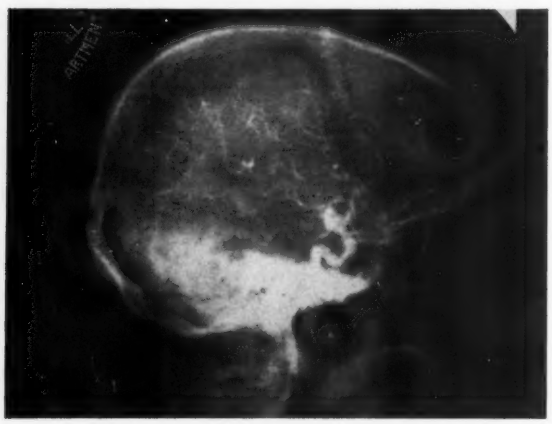

FIG. 23. Case IX. Right carotid angiogram. Film 1 of lateral series.

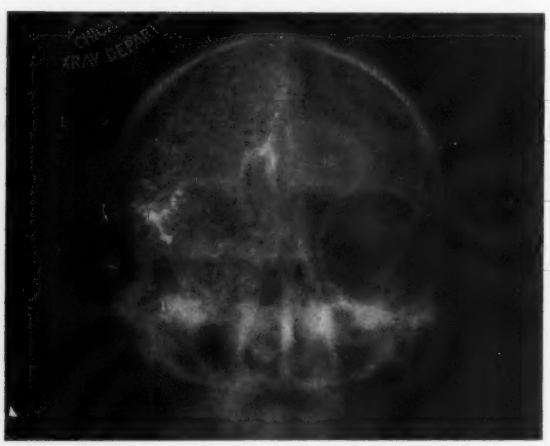

FIG. 24. Case IX. Right carotid angiogram. Film 6 of anteroposterior series. The cortical vascular pattern is displaced away from the skull in a saucer-like fashion.

CASE IX. R. McG., male, aged fifty-one, was first seen May 26, 1950. He had had generalized headaches for three weeks with recurrent dizziness, especially on postural change. His family had noted increased irritability with poor memory and occasional mental confusion for the same period of time. A history of injury was specifically denied.

Examination revealed no positive neurological findings except early bilateral papilledema. The spinal fluid was clear, with a pressure of 135 mm., but contained 68 mg. of total protein. An electroencephalogram revealed no significant abnormalities. Percutaneous bilateral carotid serial angiography was carried out. Figure 23 is film 1 of the right lateral series, Figure 24 is film 6 of the right anteroposterior series, Figure 25 is film 2 of the left lateral series, and Figure 26 is film 5 of the left anterolateral series. The displacement in the anteroposterior series on each side of the cortical vascular pattern is best seen in the late films and is diagnostic of a subdural hematoma or hydroma.

The patient was explored through bilateral posterior parietal burr holes on June 2, 1950, and large chronic liquid subdural hematomas, each containing approximately 70 cc. of chocolate colored fluid, were evacuated. The patient made a rapid and uneventful recovery. He re-

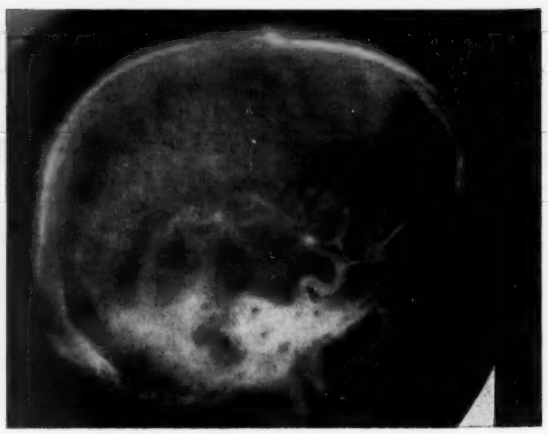

FIG. 25. Case IX. Left carotid angiogram. Film 2 of lateral series.

Fig. 26. Case IX. Left carotid angiogram. Film 5 of anteroposterior series. Again the cortical vascular pattern is displaced away from the skull.

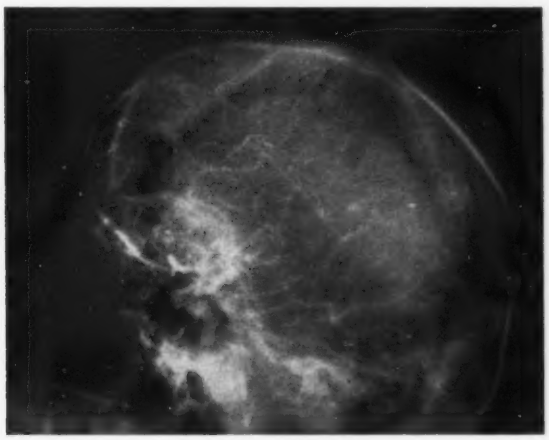

Fig. 27. Case X. Left carotid angiogram. Film 2 of lateral series. The middle cerebral artery appears to turn upward and then anteriorly to end near the sphenoid ridge.

turned to his usual work as an elevator operator a month later.

Comment. A man in his seventh decade, who gave no history of head injury, presented a history suggestive of organic brain disease. The only objective findings were early papilledema and slight increase in the total protein content of the spinal fluid. An electroencephalogram was considered normal. Bilateral carotid serial angiography revealed the characteristic picture of bilateral subdural collections of fluid. Bilateral surgical drainage of the chronic subdural hematomas was followed by prompt recovery.

Case X. R. K., male, aged twenty-nine, was first seen February 3, 1949. Two days before, he had had a generalized seizure in his sleep. There were no other complaints and no history of previous seizures in the patient or any member of his family.

Examination revealed slight increase in the tendon reflexes on the right with an equivocal Babinski response. Roentgenograms of the skull failed to reveal any bony abnormalities. An electroencephalogram was essentially normal. An attempt at percutaneous left carotid angiography was not successful and on February 16, 1949, left carotid serial angiography was performed after surgical exposure of the carotid vessels in the neck. Figure 27 is film 2 of the lateral series. The distal part of the middle cerebral vessels is not well filled and the artery appears to turn forward, ending at the sphenoid ridge. Figure 28 is film 1 of the anteroposterior series. There is no displacement of the anterior cerebral artery noted in this film. The angiographic diagnosis was not clear but an arteriovenous communication was suspected. Left frontoparietal osteoplastic craniotomy was carried out on February 21, 1949. When the temporal lobe was elevated, a large vein could be seen running anteriorly from the lateral sinus to the sphenoid ridge. Here it coursed around the tip of the temporal lobe and disappeared in the sylvian fissure. Immediately, the vein distal to the clip became dark blue in color and corresponded to the appearance of the

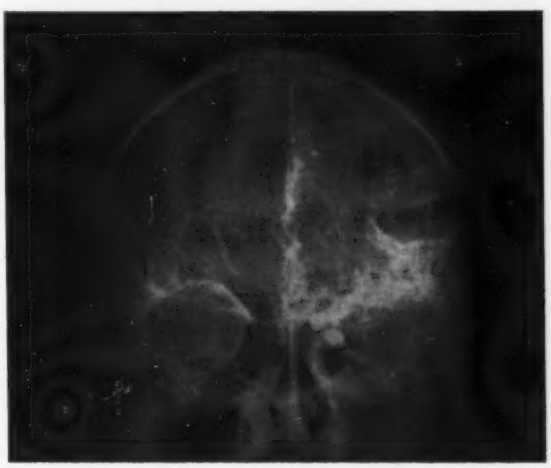

Fig. 28. Case X. Left carotid angiogram. Film 1 of anteroposterior series. There is a tortuous vessel beneath the lateral part of the temporal lobe.

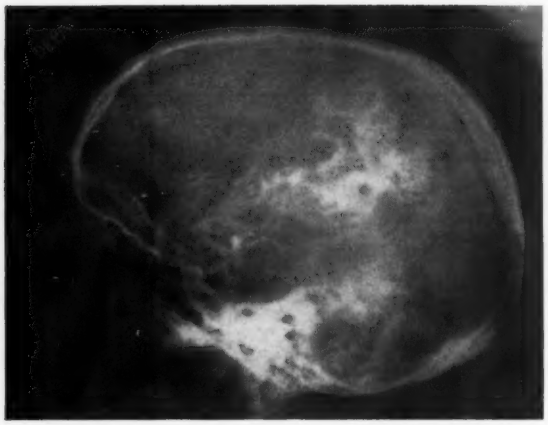

FIG. 29. Case XI. Left carotid angiogram. Film 1 of lateral series. The angiomatous malformation in the posterior parietal region receives its blood supply from the middle cerebral artery. There is no filling of the anterior cerebral artery.

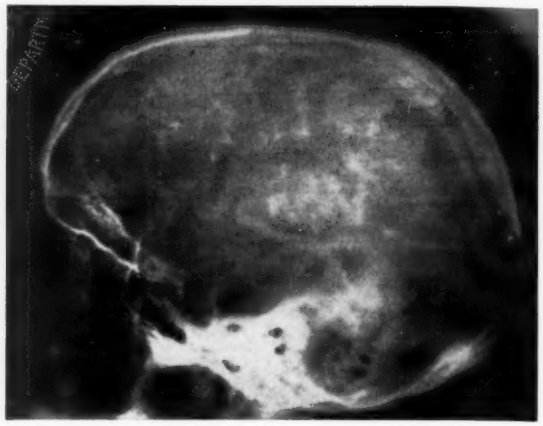

FIG. 30 Case XI. Left carotid angiogram. Film 6 of lateral series. This film shows the venous channels draining the lesion.

cortical veins. The wound was closed in the usual way.

Following operation there was temporary dysarthria and asterognosis of the right hand. These signs rapidly improved and at the time of dismissal from the hospital had entirely cleared up. He returned to his work as a police officer. A year later he had had no further attacks and was working regularly.

Comment. A man late in the third decade had a generalized seizure in his sleep. He presented mild pyramidal tract signs on the right. Carotid serial angiography suggested an arteriovenous communication of the middle cerebral artery with the sphenoparietal sinus. At operation an arteriovenous communication between the middle cerebral artery and the lateral sinus was demonstrated and occluded with a clip. A year later the patient was well and working steadily.

CASE XI. F. U., male, aged forty, had had convulsive seizures for twelve years. He was first seen on July 11, 1950, because of stupor and right hemiparesis of twenty-four hours' duration. His wife stated that for ten days he had had persistent headache. This had been more severe the day before and there had been vomiting before the patient became stuporous.

Examination revealed moderate weakness of the right side with right hyperreflexia and bilateral Babinski responses. The patient was stuporous and dysarthric when aroused. There was bilateral papilledema with recent hemorrhages in the right retina. Percutaneous left carotid serial angiography was carried out. Figures 29 and 30 are films 1 and 6 respectively from the lateral series. The large angiomatous malformation in the left parietal region receives its blood supply from the middle cerebral artery. The venous drainage of the lesion is well shown.

The patient's stupor deepened. On July 19, 1950, a left frontoparietal osteoplastic craniotomy was carried out. When the flap was reflected the dura was plum colored and under great tension. After opening the dura, a subdural unencapsulated hematoma about 1 cm. in thickness, consisting of tarry-like blood, was evacuated. The hemisphere bulged markedly into the operative field. Although the angiograms gave invaluable information about the arterial supply and venous drainage, there was great difficulty with the resection of the lesion because of the acute swelling of the cerebral hemisphere. Because of this swelling, it was necessary to leave the dura open and discard the bone flap, even though the cavernous angioma was completely removed. The patient withstood the procedure fairly well, receiving 2,500 cc. of whole blood and 500 cc. of plasma during the operation. For twenty-four hours his general condition was satisfactory but he did not regain consciousness. The second day after operation he gradually failed and finally died. Necropsy showed no evidence of postoperative hemorrhage. There was marked swelling of the left cerebral hemisphere with pressure cones at

the incisura of the tentorium and the foramen magnum.

Comment. A man just beginning the fifth decade had had generalized seizures for several years. He developed evidence of increased intracranial pressure and a left cerebral lesion. Left carotid serial angiography disclosed a large cavernous angioma of the left parietal lobe and demonstrated its arterial supply and venous drainage. At operation there was a complicating acute subdural hematoma and acute cerebral swelling. The patient did not survive the operation. Death was apparently due to increased intracranial pressure due to the acute cerebral swelling.

SUMMARY

Space occupying intracranial lesions displace blood vessels. Consequently the most dependable angiographic sign of the presence of such a lesion is displacement of the blood vessels. Anteroposterior films as well as lateral films are indispensable in the angiographic diagnosis of space occupying lesions. Tumors of the frontal or anterior temporal lobes will displace the anterior cerebral artery to the opposite side of the midline. Anterior frontal tumors will interfere with filling of the anterior cerebral artery or displace it posteriorly, obliterating its anterior convexity. Tumors of the parietal lobe depress the middle cerebral vessels and widen the distance between these vessels and the anterior cerebral vessels. Temporal lobe tumors elevate the middle cerebral vessels. The more posterior a space occupying lesion in the cerebral hemisphere, the less the displacement of the anterior cerebral vessels across the midline. The posterior cerebral artery is seldom filled in carotid angiograms and consequently parieto-occipital neoplasms may be difficult to diagnose by this procedure. Gliomas of the brain stem may be recognized by displacement of the basilar artery. Sellar and parasellar lesions usually displace the anterior cerebral artery upward. This is best seen in anteroposterior views.

As Fabritius, Frovig and Kristiansen[5] have shown, cerebral abscesses displace the intracranial vessels just as do tumors. Subdural hematomas have a diagnostic pattern of displacement best seen in anteroposterior views. The cortical vessels are displaced away from the skull by the hematoma, leaving an area of apparent avascularity between the cortex and skull. Subdural hematomas and abscesses are avascular lesions, although an abscess of long standing may have sufficient vascularity of the capsule to outline it in the angiogram.

Neoplasms often have a characteristic vascular pattern. Meningiomas can frequently be outlined by their capsular vessels. Their intrinsic vessels may be so profuse that the tumor appears as a solid or mottled mass. Glioblastomas often show marked vascularity. Metastatic lesions are usually well outlined by their blood supply and, if multiple, such lesions can be better demonstrated by angiography than by air studies. The more avascular gliomas, astrocytomas, and oligodendrogliomas often show no vascular pattern and are recognized by the displacement of blood vessels alone.

The demonstration of arterial supply and venous drainage of vascular neoplasms and vascular malformations is best made by serial angiograms. The information thus gained is of great help in planning and carrying out surgical procedures.

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PLEURAL CALCIFICATION RESULTING FROM EXPOSURE TO CERTAIN DUSTS

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THE deposit of calcium on the pleural surfaces of the lungs and chest cavity is commonly recognized as an occasional sequela of pleurisy, either tuberculous or otherwise, of empyema, and of injuries followed by hemothorax. Beverly[2] says that while the etiology is debated, the exciting cause is pleural irritation, traumatic, infectious, or chemical. However, in the well known pneumoconioses, such as silicosis and asbestosis, where pleural involvement is the rule, pleural calcifications, though occasionally reported, do not appear to be a particularly frequent feature of the pathological picture. In fact, with the exception of a previous report by the authors[10] calcareous pleurisy has not been associated with any dust exposure.

It has been the experience of this Division, however, in making chest roentgen surveys of workers in dusty trades that there are certain dusts exposure to which is associated with a conspicuously higher incidence of pleural calcifications than is to be expected in routine chest surveys.

Calcific pleural plaques are, generally speaking, relatively rare. In a study at Sea View Hospital where 80 per cent of those examined had tuberculosis, Taylor and Schwartz[11] reported 10 cases in three years among 10,000 examined, making an incidence of 0.1 per cent. Head[5] quotes Ulrich as reporting 16 cases among 1,845 examined, an incidence of 0.8 per cent.

In Table 1 the experience of the Division of Industrial Hygiene is shown. Here are presented the number of cases showing pleural calcification in studies made in a number of occupational groups exposed to various dusts, both organic and inorganic.

It is at once apparent from Table 1 that, while the incidence of pleural calcification in the majority of groups ranges from zero to 0.3 per cent, four groups, namely those exposed to the dust involved in making bakelite insulators, to calcimine, mica and tremolite talc show a conspicuously higher proportion of such findings. Of these, the talc group is outstanding with an incidence for pleural calcifications of 6.3 per cent.

GROUPS SHOWING INCREASED INCIDENCE OF CALCIFIC DEPOSITS

The group of 221 men exposed to tremolite talc dust comprised millers and miners of tremolite talc in five mills and three mines in the northern part of New York State.

Chemically, this talc is a calcium magnesium silicate. Physically, it closely resembles asbestos in its fibrous structure.

TABLE I

INCIDENCE OF PLEURAL CALCIFICATION FOUND IN VARIOUS ROENTGEN SURVEYS MADE BY THE DIVISION OF INDUSTRIAL HYGIENE

Type of Dust	Number Roentgenographed	Number Showing Calcifications	Per Cent Showing Calcifications
Asbestos	261	0	0.0
Bakelite insulators	197	3	1.5
Brick	1,278	3	0.2
Calcimine	114	2	1.7
Carpets—wool	1,140	0	0.0
Cement	899	2	0.2
Cleansing powder	140	0	0.0
Cotton	886	2	0.2
Fur	404	1	0.2
Grain	394	0	0.0
Leather	1,546	0	0.0
Mica	302	5	1.6
Pottery	997	3	0.3
Tremolite talc	221	14	6.3

* No longer with the Division of Industrial Hygiene.

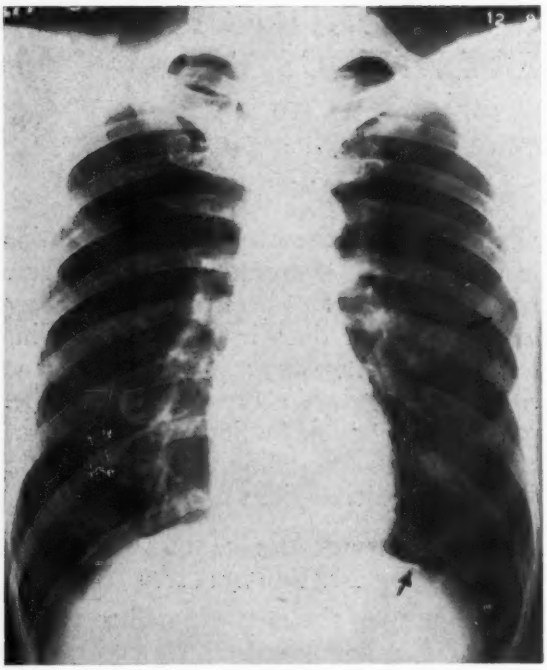

Fig. 1. Case 1. Mica insulator sawyer. Aged fifty-two; exposure thirty-six years. There are calcific pleural plaques over the left mid-lung field and over the left diaphragmatic pleura.

It was found to be capable of causing a severe, incapacitating pneumoconiosis. Findings in regard to the dust exposure and incidence of pneumoconiosis among tremolite talc workers have been reported upon elsewhere.[2]

The group of 302 men exposed to mica dust were employed by a concern engaged in making mica insulators of various types. Mica is a complex silicate of potassium, aluminum, magnesium, calcium and fluorine. A number of operations in the plant were dusty including the sawing, sanding, and drumming of insulators. None of the mica workers in this study showed pneumoconiosis, though Dreessen *et al.*[3] have found that mica dust is capable of causing this condition when present in sufficient intensity.

The bakelite insulator group included 197 employees of two concerns engaged in making bakelite insulators. These are made of a mixture of bakelite to which both talc and mica are added as filling. After mixing, the material is shaped in hot presses and the insulators are subsequently finished by buffing. Except for the job of batch-mixing the work is not conspicuously dusty. No cases of pneumoconiosis were found in this group.

The calcimine group was the smallest of the four. It included 114 individuals employed in three plants where calcimine, a form of water-soluble paint, was manufactured. This material is a mixture of whiting, clay, talc, silica, mica and asbestos. Since manufacturing processes involved operations such as crushing, blending, and bagging, dust exposure was considerable. Four cases of silicosis were diagnosed in this group.

Inasmuch as two of the groups which show an increased incidence of pleural calcification are associated with exposure to tremolite talc and mica, and the other two groups had exposure to mixed dusts which

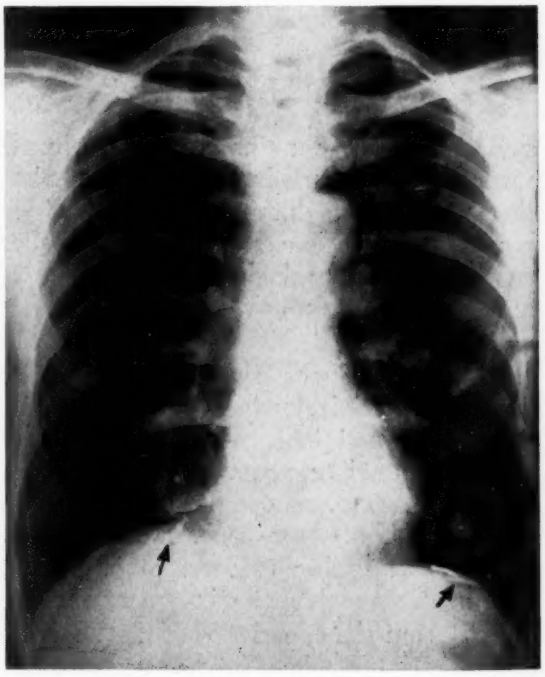

Fig. 2. Case 11. Tremolite talc mill machinist. Aged sixty-five; exposure twenty years. The lungs are negative with the exception of multiple small circular shadows, some of calcific density, in the right second and third interspaces, and calcific pleural deposits over the left mid-lung field, the left diaphragmatic pleura, and at the right anterior costophrenic sinus.

included talc and mica, it would seem probable that talc and/or mica dust may have been responsible for the calcifications found in all four groups.

ROENTGEN APPEARANCES

The type of calcific plaque noted in these groups varied in size from a single linear appearing deposit of a few centimeters in length in the region of the diaphragm to massive deposits, bizarre in shape, extending over a large part of both lung fields. Among the mica workers, in addition to calcific pleural deposits, there was a conspicuous proportion of cases which showed an excessive amount of calcification of the hilar lymph nodes.

Figures 1, 2 and 3 present 3 examples of calcific pleural deposits at an early stage; 1 in a mica sawyer and 2 in tremolite talc mill workers. One example of excessive calcification of the hilar nodes in a mica worker is also shown (Fig. 4). In each of the first 3 cases there are calcific deposits over the diaphragmatic pleaur with small

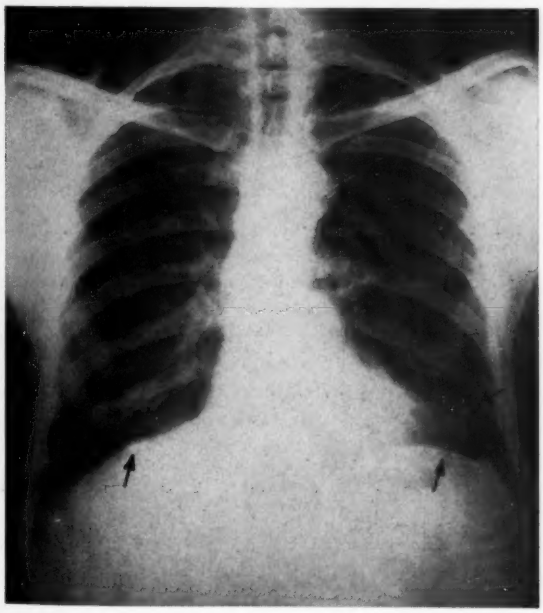

Fig. 3. Case III. Tremolite talc crusher operator. Aged forty-seven; exposure seventeen years. Both lungs show increased density in the lower lung fields. At the left base is a small calcific deposit. Similar deposits are present bilaterally on the diaphragmatic pleura.

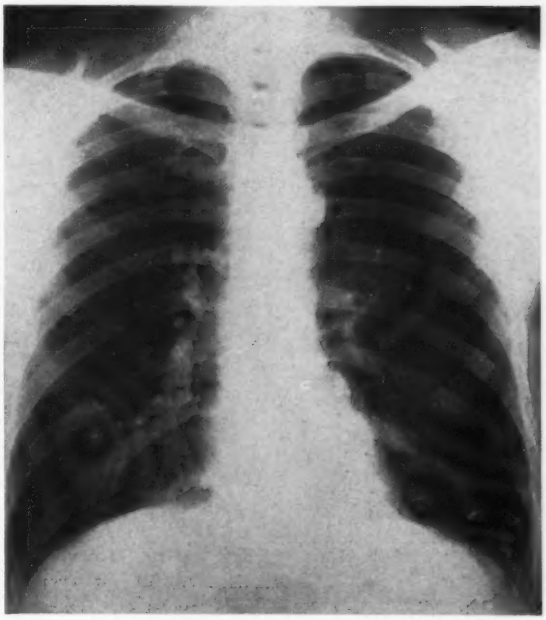

Fig. 4. Case IV. Mica mill operator. Aged thirty-nine; exposure fourteen years. The hilar nodes on both sides, especially the right, show numerous, dense calcific deposits. Small calcific deposits are present in the adjacent lung fields.

or light deposits over the middle or lower lung fields. In 2 of these cases the lungs are otherwise negative. In the third, talc pneumoconiosis is also present.

Cases showing slightly more advanced degrees of calcification are presented in Figures 5, 6, 7 and 8. They include 3 tremolite talc mill workers, and a bakelite insulator buffer. The 3 tremolite talc cases show the almost characteristic calcific plaques over the diaphragmatic pleura as well as deposits over the middle and lower lung fields. In 2 of these cases (Cases VI and VII) talc pneumoconiosis is also present. In the case of the bakelite buffer (Case VIII) the lungs are clear, with the exception of calcific deposits over the middle and lower left lung field.

In Figures 9, 10, 11 and 12 advanced degrees of pleural calcification are shown in 2 tremolite talc miners, a mica insulator sander, and a bakelite insulator buffer. Here again the 2 talc cases show calcific deposits over the diaphragmatic pleura. These are particularly heavy in Case IX,

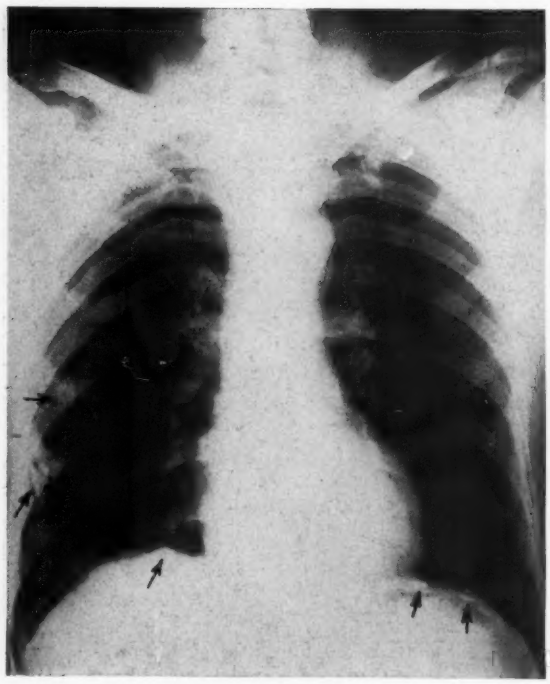

Fig. 5. Case v. Tremolite talc mill laborer. Aged fifty; exposure four years. Calcific pleural plaques are present over the right lower lung field and over both diaphragmatic pleurae.

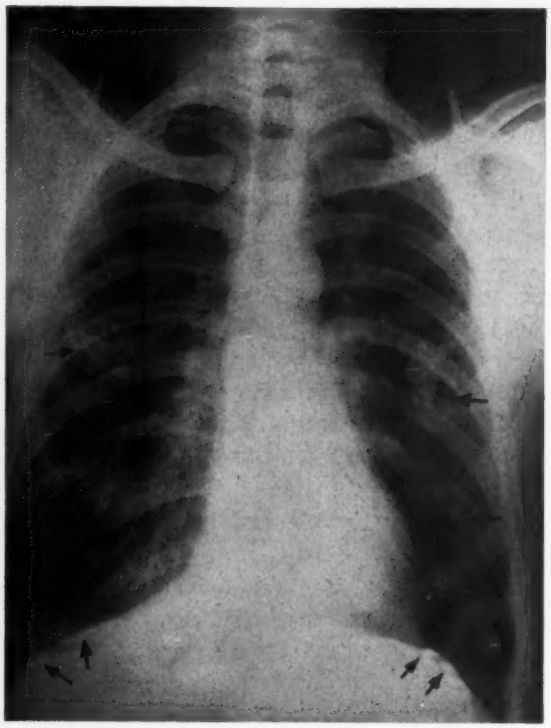

Fig. 6. Case vi. Tremolite talc mill repairman. Aged forty-nine; exposure eighteen years. The lungs show increased markings with mottling. Calcific pleural plaques are seen over both lung fields and bilaterally on the diaphragmatic pleura.

which also shows calcific deposits at the right heart border and in the aortic knob, in addition to extensive calcific plaques over both lung fields. The second tremolite talc case in this group (Case x) shows a calcific deposit along the left heart border and extensive plaques over the left lung field. In this case there are also shadows suggesting minimal tuberculosis in the right lung. The shadows in the second left interspace probably represent a continuation of the pleural plaques.

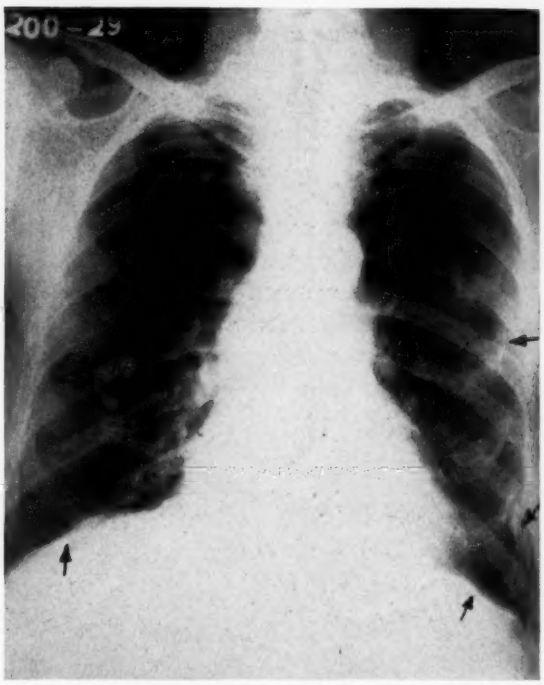

Fig. 7. Case vii. Tremolite talc mill foreman. Aged fifty-nine; exposure eighteen years. Both lungs show increased markings with mottling in both middle and lower lung fields. Scattered calcific deposits are present over the mid-lung fields on both sides, and at the left base. Bilateral calcific deposits are present over both diaphragmatic pleurae.

The third case in the group (Case xi), that of the mica insulator sander, presents a striking picture of pleural calcification which appears to form almost a shell over the lower and middle lobes.

Case XII is that of a bakelite insulator buffer where the age and length of exposure are almost identical with those in the first bakelite case shown (Case VIII). Here, however, the deposits cover a considerably larger area on both sides.

CLINICAL STUDY OF TALC WORKERS

In the tremolite talc study the men showing talc pneumoconiosis and those

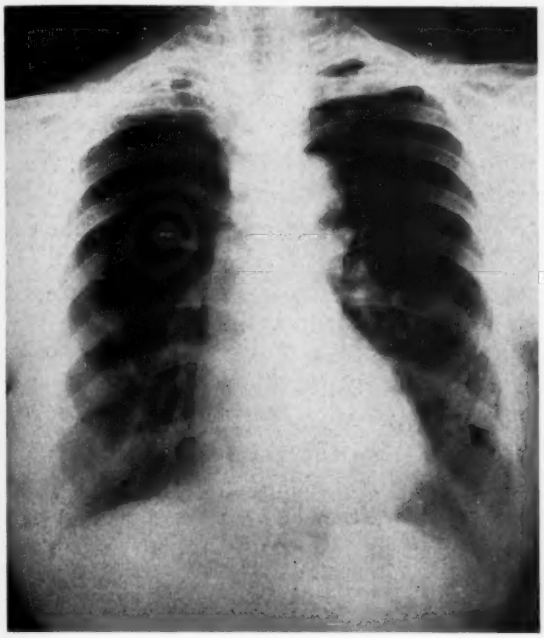

FIG. 8. Case VIII. Bakelite insulator buffer. Aged fifty-one; exposure thirty-nine years. The lung fields are clear with the exception of apical pleural caps and calcific pleural plaques over the left mid-lung field.

with calcific pleural plaques were examined clinically and questioned as to their medical histories but it was not possible to find definite correlations between the presence

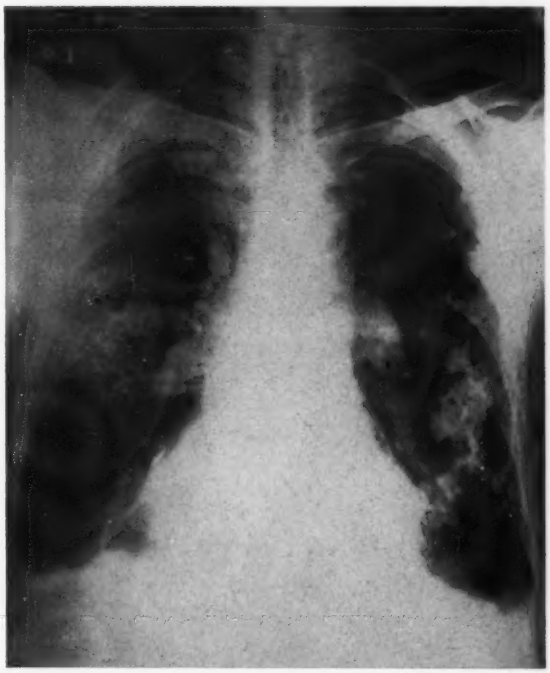

FIG. 9. Case IX. Tremolite talc miner. Aged sixty-three; exposure two years in talc mines, four years in a talc mill, and three years in a zinc mine. There are extensive calcific pleural plaques over both lung fields and on the diaphragmatic pleura. The costophrenic sinuses are obliterated. The heart is displaced to the right and there is a calcific deposit at the right heart border and in the aortic knob. Bilateral apical caps are present.

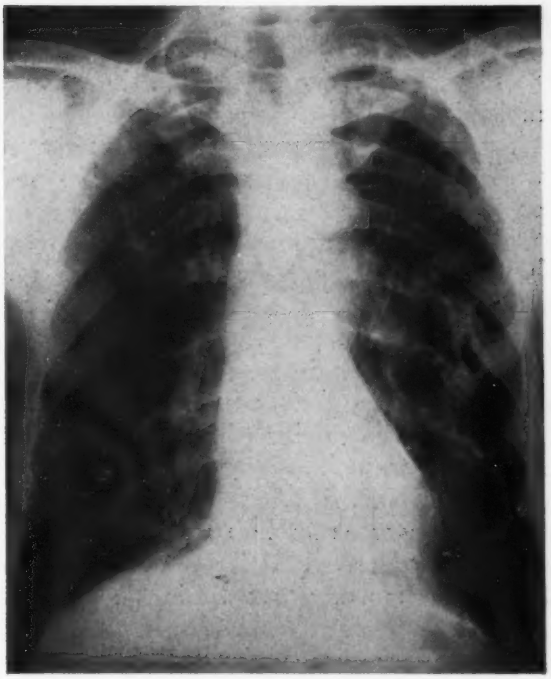

FIG. 10. Case X. Tremolite talc miner. Aged sixty-two; exposure forty-six years. There are extensive irregular calcific pleural plaques over the left lung field, including the second intercostal space. Calcific plaques are also seen over the diaphragm and along the left heart border. Soft infiltration, probably tuberculous, is present between the first and third anterior ribs on the right side. There are bilateral apical caps.

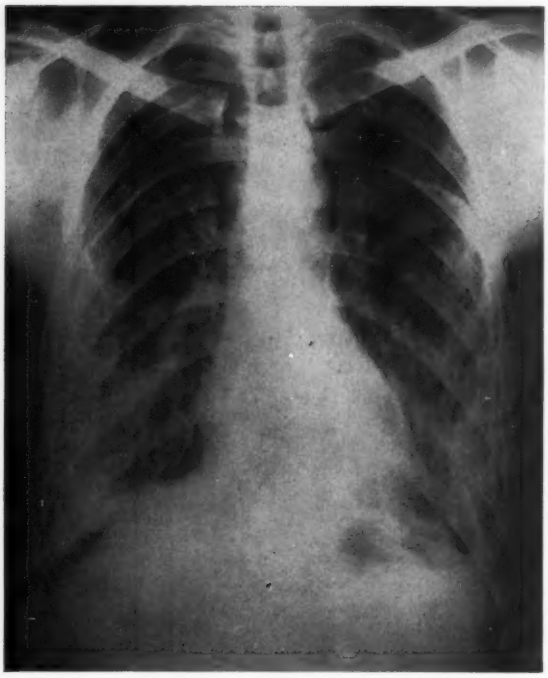

FIG. 11. Case XI. Mica insulator sander. Aged thirty-three; exposure seventeen years. There are extensive calcific pleural plaques over the lower two-thirds of both lung fields. In addition to numerous small nodular deposits, the pleura is well outlined by continuous calcific deposits along the lateral chest walls and mediastinum.

of calcific deposits and age, length of exposure, or history of previous respiratory disease. In half of these cases, however, there was evidence of a coexisting pneumoconiosis.

An analysis of the group of 14 talc workers who showed calcific deposits revealed the following facts: Their ages varied from thirty-five to seventy-seven years and their exposure in the talc industry from four to fifty-two years. Only 1 individual gave a history of pleurisy. None had had empyema or any serious chest injury. In 5 cases no lung pathology other than the calcific plaques was noted. In 7 there was an accompanying pneumoconiosis. Evidence of clinically significant tuberculosis was seen in 2 cases and of primary healed tuberculosis in 1 other case. No symptoms or physical signs attributable to the calcific deposits could be identified since symptoms and signs only occurred in individuals in whom there was other lung pathology.

PATHOLOGY OF TREMOLITE TALC PNEUMOCONIOSIS

Reports of pathological studies of the lungs of talc workers are meager, and of mica workers, non-existent. However, as already stated, it is known from Dreessen's[3] roentgen studies that mica dust can cause pneumoconiosis. Published accounts of autopsies on cases of talc pneumoconiosis have been limited to the articles by Porro, Patton and Hobbs,[8] and Porro and Levine.[9] These authors found active fibrous tissue proliferation not unlike that seen in asbestosis. A characteristic feature of all but the least involved cases was found to be extensive intrapleural adhesions, though no cases showing calcification were included among those autopsied.

In an unpublished report of a study on pneumoconiosis in tremolite talc miners made at the Saranac Laboratory of the Trudeau Foundation, calcified pleural plaques were not found in a series of 8 cases, but they did show "the regular occurrence of acute and chronic pleurisy."

There is available to the author the report of an autopsy in a case where a claim

FIG. 12. Case XII. Bakelite insulator buffer. Aged fifty-four; exposure thirty-nine years. Calcific pleural deposits are present over both middle and upper lung fields, more clearly defined on the left.

for compensation had been made for talc pneumoconiosis. Connective tissue proliferation largely distributed about the peripheral arterioles and smaller bronchioles was found. Here pleural calcification was a conspicuous feature. The description of the condition of the pleura found in this case is as follows:*

"Both pleural spaces are obliterated by dense fibrous adhesions. It is necessary to strip outside the parietal pleura in order to mobilize the lungs. There is a dense calcified plaque in the parietal pleura on the left."

The anatomical diagnosis here includes "tremolite talc pneumoconiosis," and "bilateral, obliterative, fibrous pleuritis with ossification in the parietal pleura on the left." The microscopic appearance was described as follows: "The chronic pleurisy is composed of dense but non-hyaline fibrous tissue built up above the original surface, but also encroaching upon the underlying lung and extending inward along the interlobular septa. Section of the calcified areas shows dense non-hyaline fibers with diffuse calcification and no necrosis."

DISCUSSION

Since the deposit of calcium on the pleura is known to be associated with pleural irritation, it may be assumed that when it occurs in workers exposed to pneumoconiosis-producing dusts it is the result of pleuritis accompanying the pneumoconiosis.† This does not explain, however, why it should occur with unusual frequency among workers exposed to tremolite talc and mica dust. Silicosis and asbestosis are also characterized by pleural involvement, but not particularly by the occurrence of calcific deposits. Apparently some factor in addition to pleural irritation is operative in the case of talc and mica dust. It seems possible that this factor may lie in the chemical composition of these dusts which may stimulate in some specific way the mechanism of calcium deposition.

It is generally accepted that calcium in the tissue fluids occurs chiefly in combination with phosphate and carbonate as tertiary calcium phosphate and calcium carbonate. The equilibrium of the solution can be easily disturbed and the precipitation of calcium may occur under a variety of circumstances. Three factors are of outstanding importance in calcium deposition, namely, the calcium concentration of the serum, the phosphate concentration of the serum, and the degree of alkalinity of the serum and tissue fluids. Calcium and phosphates bear a reciprocal relation to each other. High serum phosphate with only a slight increase in calcium will result in calcification of soft tissues.

Kay[7] found that magnesium ions have a greater activating effect on all animal phosphatases than any other kations. Phosphatase in turn plays a part in making available phosphate ions necessary for the deposition of calcium phosphate,[4] hence factors favoring an increase in phosphatase will favor calcium deposition.

Tremolite talc contains magnesium as well as calcium, since it is a calcium magnesium silicate. In muscovite mica also we have a dust containing both magnesium and calcium. This combination of calcium and magnesium distinguishes tremolite talc and muscovite mica from asbestos, another pneumoconiosis-producing dust which is likewise a magnesium silicate, but which is not associated with pleural calcification.

On theoretical grounds, therefore, it is suggested that the reason why tremolite talc and muscovite mica dust produce calcific pleural deposits in a relatively high proportion of cases is that, in addition to being capable of causing pneumoconiosis with associated pleural irritation, they also contain chemical elements, namely calcium

* Personal communication to the author from Dr. A. Vorwald of the Saranac Laboratory.

† The question arises as to why calcific pleural plaques occur in cases where no evidence of pneumoconiosis is seen on the roentgenogram, but it should be remembered that pleural involvement occurs early in pneumoconiosis. Strachan[9] in discussing pleural lesions in silicosis says that they give no indication of the degree of severity of the lesions within the lung, and that they may be numerous in cases in which the lung substance shows little or no nodulation.

and magnesium, which tend to promote calcium deposition.

It is hoped that an opportunity to test this hypothesis by suitable studies of the blood chemistry in these workers will be afforded at a future date.

SUMMARY AND CONCLUSION

An increased incidence of pleural calcification is found in workers exposed to the dust of tremolite talc and muscovite mica. It is suggested that this may be due to pleural irritation produced by these dusts plus the presence in them of calcium and magnesium which act to stimulate calcium deposition.

The author gratefully acknowledges the assistance of Dr. Hans Abeles who reviewed the roentgenograms with her, and of Mr. Martin Gill, photographer, who made the prints, both of the New York City Department of Health. The author is also indebted to the New York State Department of Health for assistance in taking the roentgenograms.

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Vol. 67, No. 3

STREPTOMYCIN IN PULMONARY TUBERCULOSIS

CLINICO-ROENTGENOLOGICAL CONSIDERATION

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IN RECENT years "drug receptors" have been identified with oxidative enzyme systems of living organisms. Effective chemotherapeutic compounds, *i.e.*, such chemical agents which are more toxic to specific pathogenic organisms than to the host, compete with the essential oxidative enzyme systems of the pathogens and inhibit their normal metabolic processes. Sulfonamides, though ineffective in the treatment of human tuberculosis, served to show that chemical agents could exert a specific metabolic effect on the tubercle bacillus, and that non-acid dissociating compounds permeate this bacillus much more readily than acid dissociating compounds.

The introduction of streptomycin gave new impetus to chemotherapy in the treatment of tuberculosis because it demonstrated conclusively its ability to influence the clinical course of the disease in man. It is the purpose of this presentation to discuss the clinico-roentgenological manifestations observed in the course of pulmonary tuberculosis treated with streptomycin,‡ and to emphasize the apparent modifications brought about by the therapeutic effects of this drug.

ADMINISTRATION

Although 3 grams of streptomycin per day was originally thought to be necessary for maximal therapeutic benefit, it now seems that 1 gram per day is sufficient.[3,6] Intramuscular administration of the drug every six to twelve hours seems preferable.[10] Collective experience may perhaps in the future provide indications for modification of this plan, since the effect of streptomycin depends most likely on its tissue concentration rather than on the blood level. For example, Steenken,[12] demonstrated experimentally that the course of the disease in cases of early minimal involvement is not altered significantly by the administration of a single as compared to a divided daily dose of the drug; but in more advanced and chronic cases, better results were obtained by more frequent administration.

Prolonged administration of streptomycin, exceeding a three month period is usually inadvisable. The tubercle bacilli are by then usually resistant, and toxic manifestations are more common, particularly since continued therapy is accompanied by a corresponding increase of the streptomycin blood level.[2]

We adopted initially a plan of treatment consisting of 750 milligrams every six hours (total of 3 grams per day) intramuscularly. Later, 300 mg. every six hours or 1.2 grams per day were used. To date, the smaller dose seems quite as efficacious, and the untoward reactions, particularly vestibular dysfunction, are less frequent and severe. Patients with laryngeal or tracheobronchial tuberculosis were placed on the same regimen except that aerosol streptomycin was added. This consisted of 200 mg. of streptomycin dissolved in 10 cc. of distilled water per day in six divided doses while the patient was awake. Cases with tuberculous meningitis received in addition 50–100 mg. of streptomycin dissolved in 10 cc. of saline intrathecally. This was given every twenty-four to forty-eight hours for two to six weeks.[5]

The patients were placed on bed rest and received the usual supportive treatment. Collapse therapy was employed whenever it was thought indicated because

‡ Based on observations made on 187 patients treated with streptomycin.

* Deceased.
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streptomycin was used primarily as an adjunct to already established methods of treatment.

COMPLICATIONS DUE TO TREATMENT

The administration of streptomycin is attended by several complications which have been described by most writers on this subject. We shall mention only the rare complication of aplastic anemia seen in 1 of our patients (Case xv). This has previously been reported in only 2 cases.[10] We shall also discuss drug fastness of the bacteria because of its bearing on the practical application of the drug, and the subsequent roentgenological interpretation.

DRUG FASTNESS

Besides the variations of response of tuberculous lesions to streptomycin, determined by differences in the phase of their phthisiogenetic development, the effectiveness of the drug is limited by the resistance of the organisms to streptomycin. This resistance, which is usually acquired, may develop in previously sensitive organisms in a period of days,[9] but requires as a rule several weeks to months,[6] probably because the growth of the tubercle bacillus is slow. It is of interest that drug fastness does not develop in guinea pigs.[6]

The present sensitivity tests are inadequate to permit an exact determination, in vitro, whether or not a favorable response to therapy can be expected. Theoretically, also while some organisms may be resistant in vitro, a marked clinical improvement may be possible, due to suppression of growth of a great number of sensitive organisms in the same individual. These observations are of clinical significance, because the action of streptomycin is, in the light of present experience, suppressive, providing at best only a buffer until such a time as the body's natural defense mechanisms are able to cope with the disease.[3] It has been a general experience, however, that, with an established drug resistance, further use of streptomycin is of little value.[10]

In acute exudative tuberculosis which is not widely disseminated and which shows satisfactory roentgen evidence of regression the sputum has been reported to be converted from positive to negative in 100 per cent of cases treated.[8] In chronic fibrocaseous tuberculosis the sputum usually remains positive.[5] However, cases with continuing positive sputum show at least a fewer number of organisms.[2]

CLINICAL CONSIDERATIONS

The effect of streptomycin used experimentally in guinea pigs is often dramatic. Animals with extensive lesions have been completely cured, as evidenced by gross and microscopic examination of organs and subinoculation of tissue. Furthermore, in about one-third of the guinea pigs, the initially positive tuberculin test became negative.[12] However, this does not occur in man.[10]

We noticed a consistent symptomatic improvement in all patients, even in the absence of roentgenological evidence of regression of the pulmonary lesions. There was an increased sense of well being, a decrease of fever, cough and expectoration; the appetite improved and the patients gained 2 to 3 pounds of weight per week during the early course of the therapy. The temperature dropped markedly within one to two weeks in many of our most toxic cases. Other writers have noted similar symptomatic response to treatment.[2] In patients who improved clinically there was usually a drop in the sedimentation rate, which in some of the more acute types of the disease was quite remarkable.

ROENTGENOLOGICAL CONSIDERATIONS

The clinical indications for the use of streptomycin depend in a large measure on the type of lesions present in each individual case. The exudative or predominantly exudative lesions respond more favorably than the productive or predominantly productive forms of the disease. In practice, such a qualitative classification of pulmonary tuberculosis is based chiefly

on roentgenological analysis. Gräff and Küpferle[4] described the roentgen characteristics of exudative and productive foci, which represent two fundamental tissue responses to inflammation. The differential criteria are provided by the periphery of the tuberculous focus. An exudative focus decreases in intensity of reaction from center to periphery, producing a shadow in the roentgenogram which has ill defined margins with a blurred borderline between focus and normal parenchyma. In contrast, a productive focus is sharply demarcated and its roentgen image has sharply defined borders. Unfortunately, such a clear differentiation is only rarely possible because encapsulated exudative foci present as sharply defined borders as productive lesions, mixed forms co-exist frequently and the progression and exacerbation of productive foci are initiated by perifocal exudation. Hübschmann[7] advanced the view that all tuberculous lesions start with an exudative phase and that productive forms of the disease are invariably secondary to the former. In his opinion, caseation occurs in productive lesions only following new exudative foci arising from their periphery, and represents essentially only a severe stage of exudative inflammation.

Serial roentgen studies of the chest in the course of streptomycin therapy frequently demonstrate the variable developmental stage of individual lesions in the same patient. In our series of cases, purely exudative lesions resolved completely. Small lobular infiltrations responded more rapidly and completely than larger confluent infiltrations in which caseation was usually present at the time of initiation of treatment. Exudative foci were usually present during exacerbation of an older process in which productive changes had previously occurred. With subsidence of the new inflammatory lesions, the older ones could be recognized more easily and showed a much slower response to treatment. It was not possible to estimate the degree of caseation in recent foci which terminated in complete resolution. It was also impossible to differentiate between tuberculous foci and perifocal reaction, which represented either small atelectatic zones or early inflammatory reaction.

When larger segments of pulmonary parenchyma were involved, the roentgen findings were those of confluent bronchopneumonia or lobar pneumonia in which occasionally early cavities already indicated caseation. Without such cavities or ulcerations, the differential diagnosis against non-tuberculous pneumonia was not possible on the basis of the roentgen findings alone. The response of such pneumonias was much slower, but even here regression could be observed. It was also interesting to observe that anatomical changes, which were already well advanced, did progress toward ultimate cavity formation, not dissimilar to cases which had no streptomycin therapy. The subsequent development of such tuberculous caseous pneumonias depends on the same factors which determine the course of tuberculosis generally. A more favorable course is frequently seen due to the effect of streptomycin on the tubercle bacillus, and the mobilization of those reactive mechanisms which aid in the healing processes, so seriously interfered with in massive and sustained infections.

It is obvious, from the observations in the literature and our own, that the clinical evaluation of pulmonary tuberculosis treated with streptomycin does not depend on the roentgen manifestations of the disease to the exclusion of all other factors determining the pathogenetic development of the disease. This is important, because, while streptomycin appears to have definitely made an important contribution toward eradication of tuberculosis, it has in no way relegated all previous methods of treatment to a secondary position. On the contrary, increasing experience indicates that bed rest, pneumothorax and thoracoplasty remain essential to the treatment of pulmonary tuberculosis. Streptomycin has perhaps helped to extend the field of operative treatment of tubercu-

losis by making resections possible with greater safety.

A. Acute Exudative Tuberculosis. The regularity with which exudative lesions regress and resolve, as well as the profound symptomatic improvement noted in the course of streptomycin treatment, leaves little doubt of the cause and effect relationship.[1,2,5,8,9,10] However, streptomycin apparently becomes ineffective as soon as drug resistant organisms develop. The eventual course of the disease depends, therefore, on the natural body defense mechanisms and their ability to cope with the tubercle bacillus. Clinical, roentgenological and bacteriological improvement has been found in practically all patients with only exudative disease treated in this manner. Jenkins *et al.*[8] found roentgenological evidence of regression within twenty-two days on an average for cases treated with streptomycin as compared with forty-three days for the controls treated on bed rest alone. The disproportion of regression between the treated and untreated patients was considerably more marked after three months. These investigators were also able to conclude that the more recent the onset of disease and the sooner treatment was begun, the more consistent was the resolution of the exudative lesions. Patients with non-confluent lesions responded much more rapidly and completely than those with a confluent type of infiltration. Practically all relapses occurred after the ninetieth day of therapy.

We have also noted that in many of our cases of the exudative type, improvement was clinically significant and sustained. However, in others it was only temporary, particularly if associated with more advanced forms of the disease. Roentgen observations further tend to reflect the therapeutic limitations of streptomycin. Exudative lesions may sometimes not regress completely, and caseation may continue within the residual foci, or in instances of advanced disease further dissemination of the tuberculous process may occur. The dissemination is either intrabronchial, or not infrequently hematogenous in character.

Thus, it would appear that streptomycin is indicated whenever temporary suppression of the disease is paramount, and such suppression will enable the patient to gain ascendency over his disease. Healing then occurs by natural processes. It

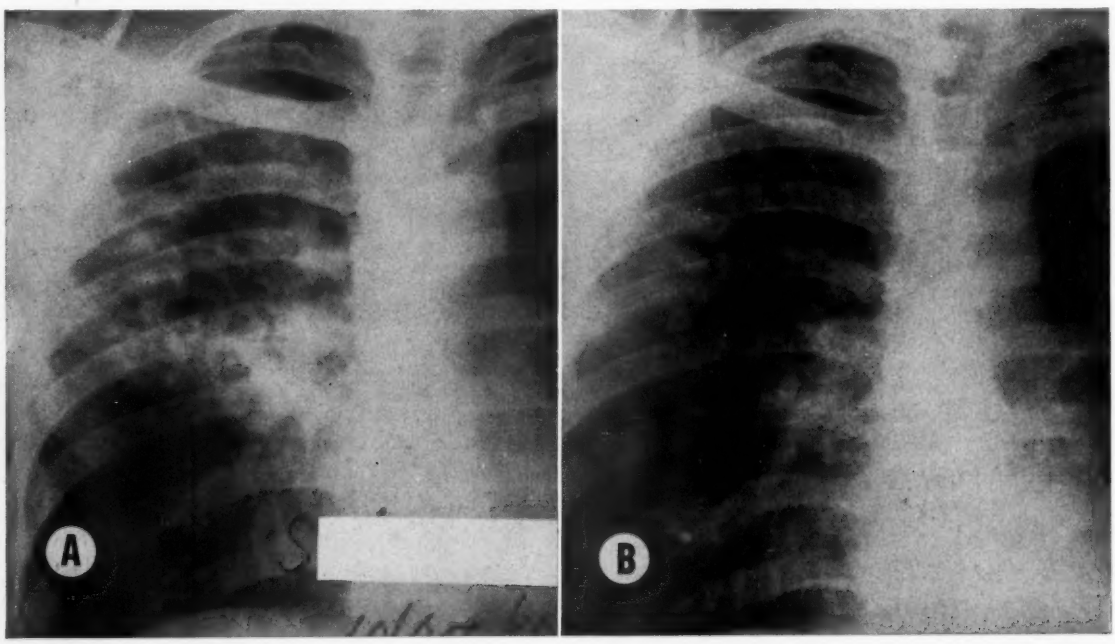

Fig. 1. Case 1. (*A*) Film two weeks after admission. (*B*) Three months after beginning streptomycin therapy.

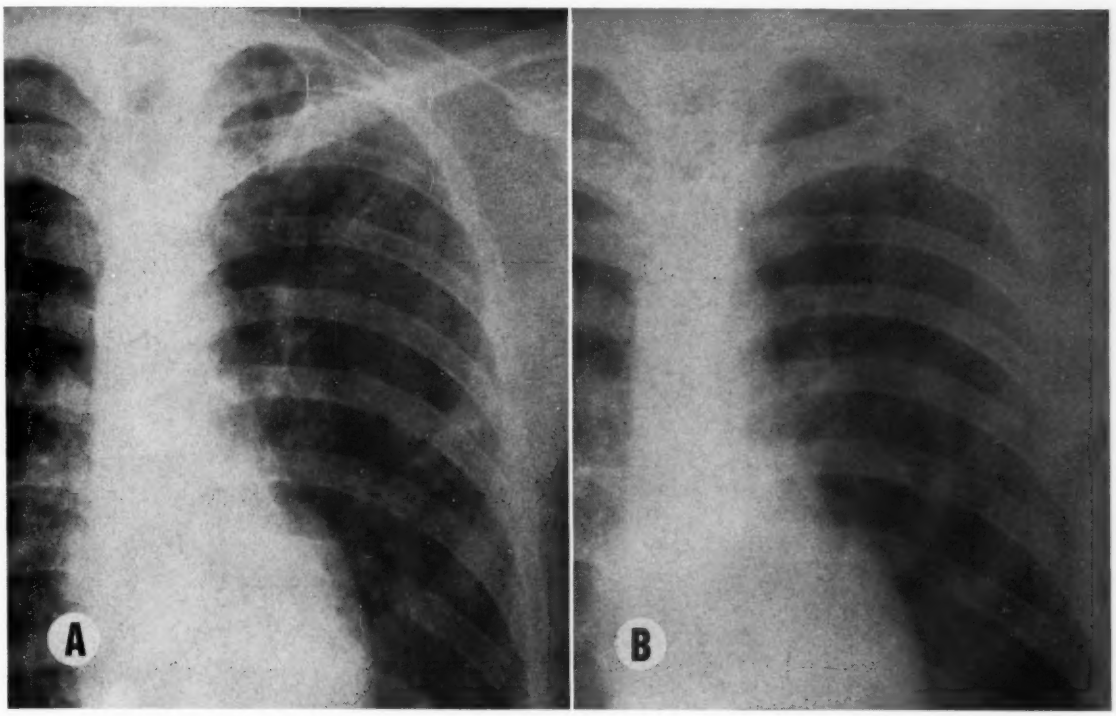

Fig. 2. Case II. (*A*) Film on admission. (*B*) Four months after beginning streptomycin therapy.

is not indicated in minimal tuberculosis, especially in view of the high incidence of toxic reaction, and the development of resistance of the organisms to the drug.

The following cases illustrate the usual response of exudative tuberculous lesions to streptomycin:

Case I. A Mexican male, aged twenty-three, was admitted because of cough, fever, and recent hemoptysis. The sputum was positive for tubercle bacilli.

Roentgen examination of the chest showed several coalescent, ill defined foci of increased density in the periphery of the right infraclavicular area. No definite cavity was demonstrable.

Within two weeks, during which time the patient was on complete bed rest, a fairly large area of recent pneumonic infiltration was demonstrable in the right parahilar area, and there were recent exudative foci in the infraclavicular portion of the right upper lobe near the periphery.

Because of manifest progression of the disease in spite of bed rest, streptomycin treatment was begun.

One month later there was considerable resorption of the exudative process. The residual infiltration was more nodular in character. The adjacent pulmonary parenchyma was essentially normal. Three months later there were only a few residual nodular densities demonstrable.

Case II. This twenty-five year old male had a pleural effusion one year previously. One month before admission he had hemoptysis attended by considerable loss of blood. After that time, the sputum remained blood streaked and it was positive for tubercle bacilli.

Roentgen examination of the chest showed numerous patches of lobular infiltration in the left upper lobe, without a definitely demonstrable cavity.

The patient was placed on streptomycin following which he improved steadily.

Serial roentgen studies of the chest showed continued regression of the initial lesions which became less numerous, smaller in size, and more sharply demarcated. Four months later there were only several small residual nodules present. The sputum was negative. It is probable that the patient had a minimal productive tuberculosis following the original pleurisy. These lesions evidently did not heal, but gave rise to new exudative lesions which responded to streptomycin by what seems roentgeno-

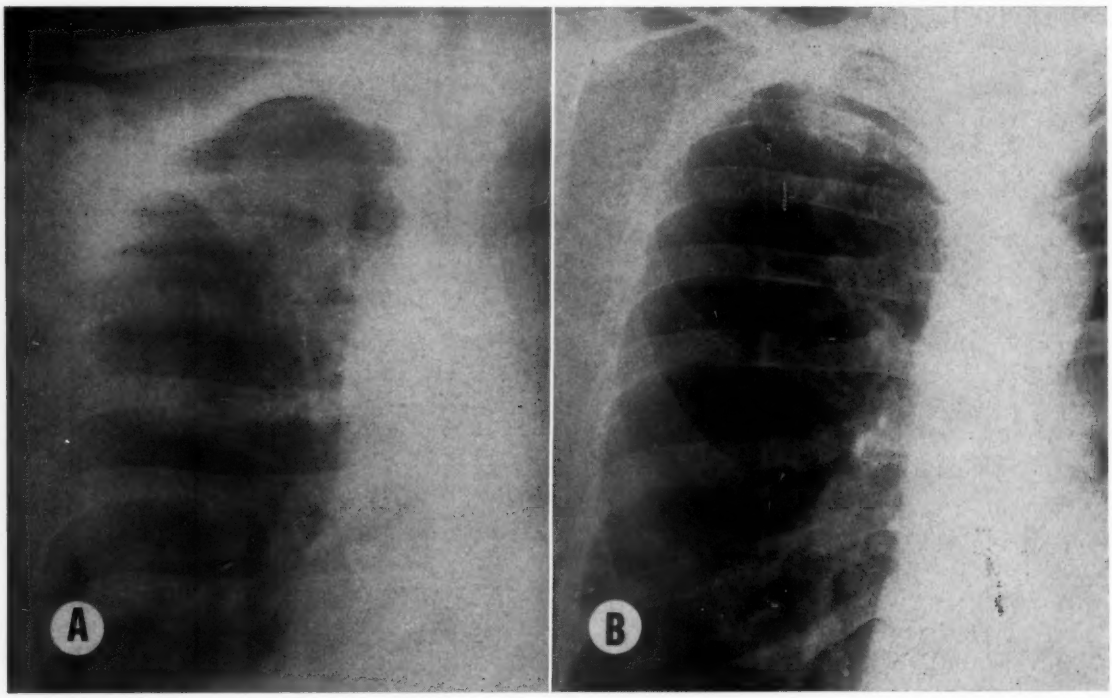

Fig. 3. Case III. (*A*) Film on admission. (*B*) Six months after beginning streptomycin therapy.

logically complete resolution. The older productive lesions did not resorb completely.

B. Chronic Fibrocaseous Tuberculosis. Despite the repeated emphasis of the fact that streptomycin has very little effect on cavitary fibrocaseous tuberculosis,[2] closure of cavities has been reported in 37 per cent of cases in addition to a decrease in the size of cavities in an equally high percentage of cases.[5,10] Certainly we have noted numerous cases of this type in whom the drug appeared to have marked beneficial effect on the course of their disease. Although conclusions cannot be based on individual cases, the frequency of apparent resolution on chest roentgenograms is noteworthy.

Case III. This forty-five year old white male was admitted because of cough, chest pain and loss of weight. Sputum studies were positive for tubercle bacilli.

Roentgen examination of the chest showed an infraclavicular area of infiltration with a central cavity.

The patient was placed on bed rest and streptomycin therapy for three months. Six weeks after admission he was asymptomatic, and the sputum contained no demonstrable bacilli.

Serial roentgenograms of the chest showed a gradual resolution of the infraclavicular infiltration and an accompanying diminution of the central cavity. No further extension of the disease was noticed from the time of initial admission. Six months later no cavity was demonstrable. There was a residual oval area of increased density in the infraclavicular area which pathologically represented one of several possibilities: (1) residual scar; (2) encapsulated caseo-exudative focus; (3) unresolved tuberculous pneumonitis, clinically inactive.

Case IV. A Mexican male, aged twenty-three, was admitted because of cough, intermittent hemoptysis and fever. The sputum was positive for tubercle bacilli.

Roentgen examination of the chest showed a pneumonic infiltration of the left upper lobe, and a cavity in the infraclavicular region. In the periphery of the third intercostal space there were several soft coalescent foci. These findings suggested an older caseous lesion with subsequent cavitation, and recent extension of the disease manifested by exudative pneumonic infiltration.

The patient was placed on streptomycin. He improved symptomatically very rapidly during the first four weeks, and then showed slow but continued improvement.

During the first month of observation, serial roentgen studies of the chest showed no significant changes from the initial appearance. Six weeks after admission a gradual resolution of the pneumonic infiltration was noticeable. The coalescent soft foci decreased in size, became more sharply defined and contrasted with the surrounding normal pulmonary parenchyma. The cavity remained unchanged. Ten weeks after admission there were only a few irregular areas of lobular infiltration in the left upper lobe. The small foci showed evidence of further absorption. The cavity was no longer visible. Six months later there was only a slight "reticulation" of the left upper lobe, and a minimal residual density at the site of the previous cavity.

Case v. A thirty-five year old white male was thought to have an arrested tuberculosis several years prior to his present admission. He had a recent recurrence of hemoptysis and loss of weight. The sputum was positive for tubercle bacilli.

Roentgen examination of the chest showed evidence of fibrocaseous infiltration in the left upper lobe. There was a fairly large cavity in the infraclavicular area surrounded by a moderately wide zone of recent exudative inflammation.

The patient was placed on bed rest and streptomycin, whereupon he improved rapidly during the first month and steadily thereafter.

Re-examination of the chest seven weeks later showed considerable regression of the pulmonary infiltration. The cavity decreased in size and the cavity wall decreased in thickness, evidently due to resorption of the infiltration surrounding it.

Three months after institution of the treatment, there was almost complete regression of the original lesion, and the cavity was no longer demonstrable. Repeated sputum examinations by both smear and culture failed to demonstrate tubercle bacilli.

While the pathologic features of the lesions in these cases are not discernible

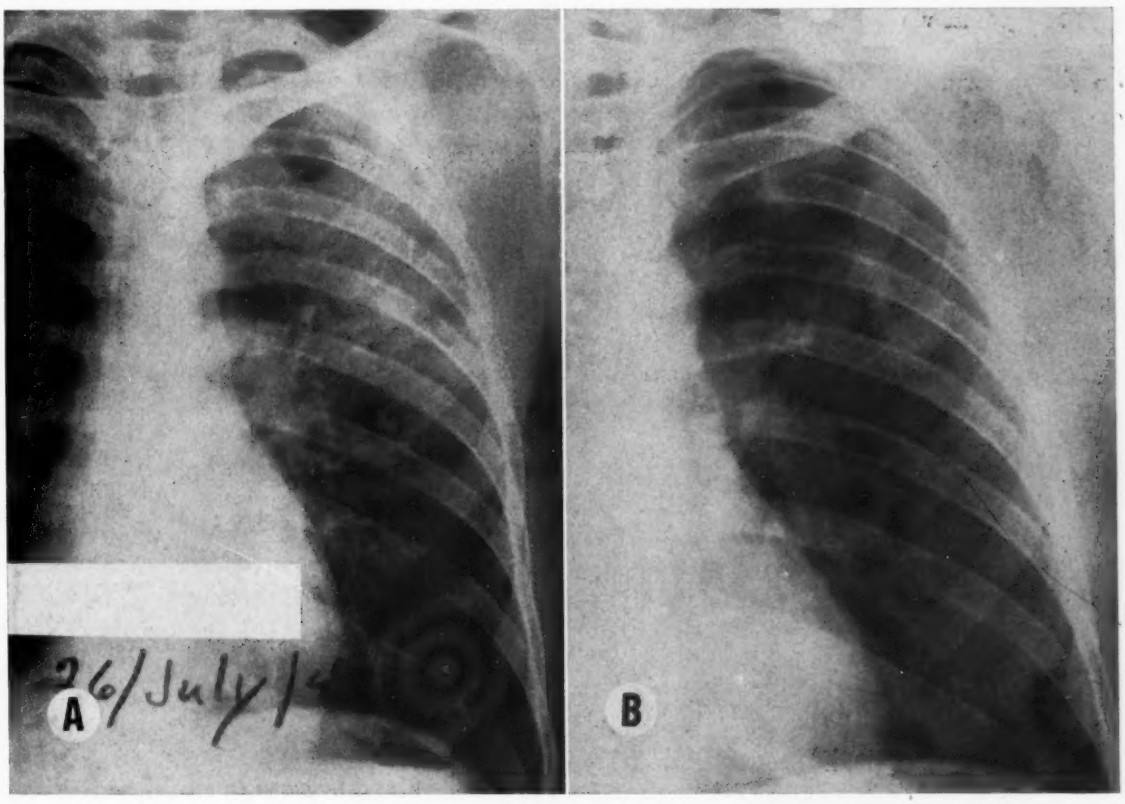

Fig. 4. Case. iv. (*A*) Film on admission. (*B*) Six months after beginning streptomycin therapy.

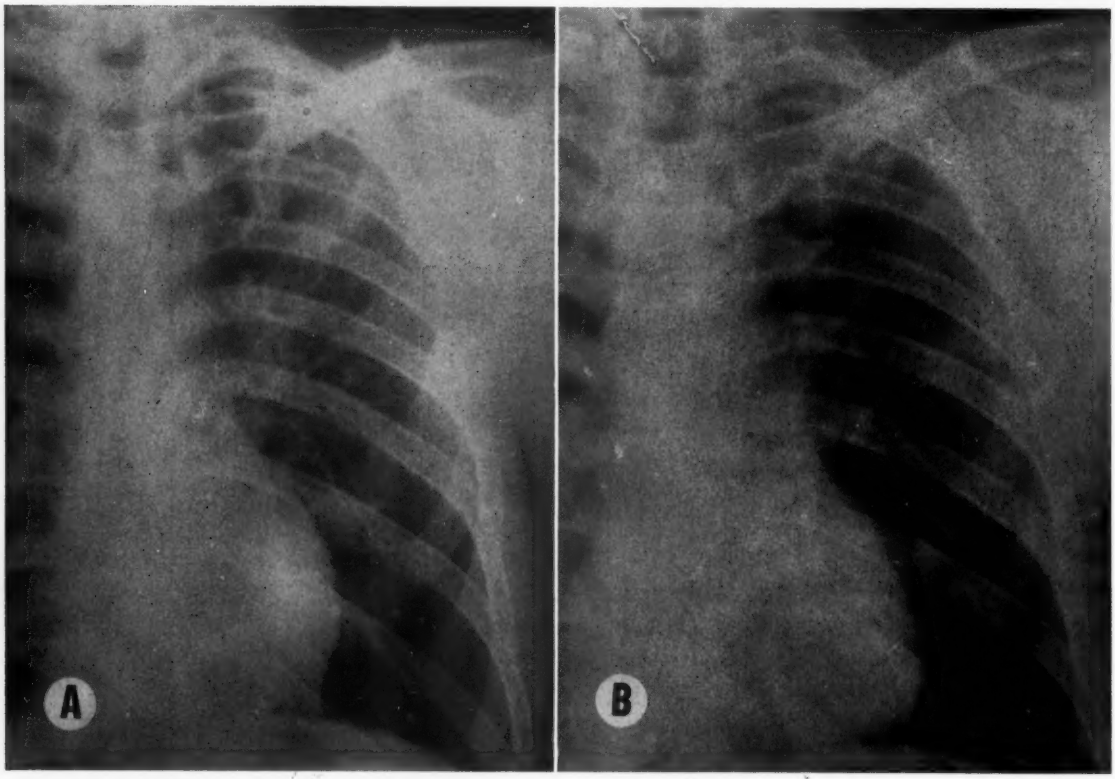

Fig. 5. Case v. (*A*) Film on admission. (*B*) Three months after beginning streptomycin therapy.

on the roentgenograms, it is of interest to emphasize the apparent disappearance of cavities on recent chest films. Cavities are, of course, unlikely to allow a restitutio ad integrum of the involved parenchyma, but they may close by the usual mechanisms. This is certainly possible in cases with limited parenchymal involvement. However, even advanced and large cavities decrease in size and some of them may escape detection on standard roentgenograms. We do not feel that it is safe to assume a complete closure on such a basis, however. The changes observed may be due to several factors. It is possible for cavities to lose their distinctive translucency because of resorption of the surrounding infiltration which delineates it against the adjacent parenchyma. It is also likely that in the course of streptomycin therapy in many cases a co-existing endobronchial disease with stenosis improves and thus, with a decrease of the intracavitary pressure, collapse of the cavity is made possible. But it is also possible for some cavities actually to decrease in size because of an adequate process of repair which eventually leaves a small scar.

Although cavity closure in fibrocaseous tuberculosis can be anticipated in a considerably higher number of patients treated with streptomycin as compared to untreated cases, this response is certainly unpredictable. In general, thin walled cavities respond much better than thick walled ones; whereas, fibrotic cavities respond very poorly, if at all.[2,5] Tension cavities do not respond as well as nontension cavities. It is quite probable that the poorer response of caseous and fibrotic lesions is due to the inefficient penetration of the drug through the caseous barrier, which is quite acid and high in lipid content. Streptomycin is alkaline and insoluble in lipids.

The sputum in chronic, fibrocaseous, cavitary tuberculosis often remains positive despite treatment, although the density of

organisms per unit volume decreases.[1] This again indicates the bacteriostatic and suppressive effect of streptomycin rather than any other action which might be capable of direct eradication of the disease. The role of the antibiotic is to block the path of extension while the healing processes of resorption, fibrosis and calcification are at work. In selecting cases for therapy, preference should be given to exceptionally active cases which cannot be handled otherwise.

Streptomycin may prove a useful adjunct when collapse therapy or surgical intervention is contemplated.[1] Thus, if streptomycin proves successful in preventing bronchogenic or hematogenous dissemination of the disease, and if it is able to reduce the incidence of empyema, it will be of great aid prophylactically and will broaden the indications for surgical treatment of pulmonary tuberculosis.

Case vi. This fifty-four year old white male was admitted because of an exacerbation of an old tuberculosis of the right upper lobe. The sputum was positive for tubercle bacilli.

Roentgen examination of the chest showed an extensive infiltration of the right upper lobe with several cavities in the periphery of the first and second intercostal spaces. The anterior segment of the upper lobe showed recent intrabronchial dissemination.

The patient was placed on streptomycin, following which he improved symptomatically.

Serial roentgen studies of the chest showed a prompt complete regression of the recent exudative lesions. The large infiltration remained essentially unchanged for several weeks. The number of demonstrable cavities increased, indicating conclusively that caseation within the pulmonary infiltration progressed considerably prior to, and most likely also during, the streptomycin treatment. Seven weeks later the density of the infiltration decreased, the lesion showed no further progression, and there was some absorption of the infiltration at the

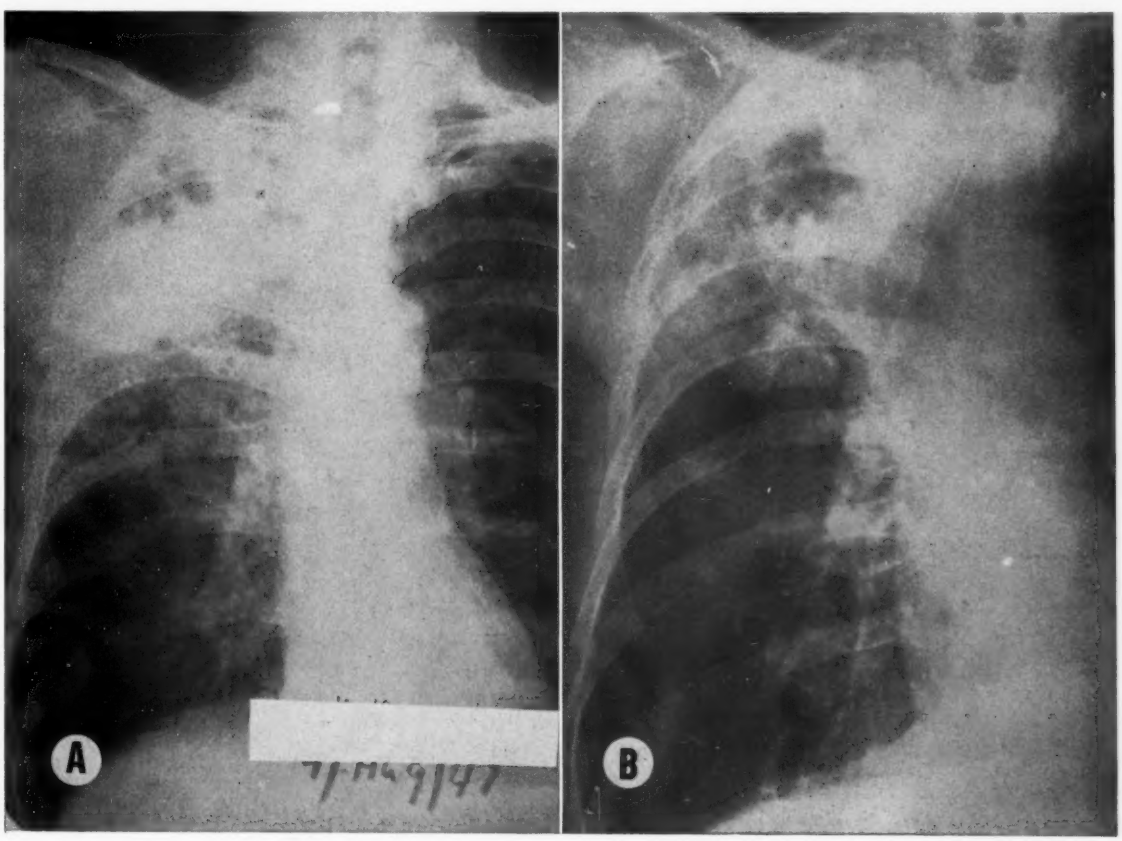

Fig. 6. Case vi. (*A*) Film on admission. (*B*) Two months after beginning streptomycin therapy.

periphery of the lesion. This slow peripheral resolution continued for some time, and at the same time the number of small demonstrable cavities increased.

We interpreted these roentgen manifestations as compatible with the pattern observed almost invariably in the course of advanced fibrocaseous tuberculosis. The exudative, noncaseating infiltration showed prompt regression. The caseation necrosis, once advanced, was not arrested but progressed to its most common conclusion, cavitation. However, the immunological status in this patient had been affected favorably, permitting the process to stabilize to an extent where collapse therapy was feasible.

Case vii. A Negro male, aged thirty, was admitted with a history of active tuberculosis with large bilateral cavities. The infiltration was predominantly confluent in character, with the peripheral lesions being somewhat more distinctly lobular in distribution.

The patient was placed on bed rest and streptomycin. Within six weeks his laryngeal symptoms cleared completely, except for slight residual hoarseness. The temperature returned to normal, and the patient gained 10 pounds in weight.

Serial roentgen studies of the chest showed some improvement one month after streptomycin therapy was begun. The large confluent exudative lesions regressed to some extent; others, which were evidently already caseous in nature, "sequestrated," leaving fairly numerous small ulcerations. The large cavities did not change significantly in size. The entire process, though still extensive, showed a definite tendency toward stabilization and regression.

The improvement observed roentgenologically was temporary. Four months after the initial treatment a recrudescence of the inflammatory reaction was obvious and again the infiltration was largely of a confluent bronchopneumonic type, with poorly defined contours and decreasing density toward the periphery. The disease was, however, limited to that portion of the lung which was affected in the original process. There was no further dissemination of the tuberculous process to areas previously not involved. This we thought rather significant. Although the roentgenologic appearance of the lesion suggested at one time a progressive healing, we were convinced that the dynamic potentialities of the disease were not reproduced in the roentgenograms. This means, as we shall point out again later, that disappearance of opacities in the course of pulmonary tuberculosis is not always synonymous with complete healing. While the perifocal reaction and atelectasis may disappear completely, the fundamental tuberculous process may remain active even though it is not demonstrable roentgenologically. On the other hand, it is strongly suggestive that exacerbations of the disease are limited to this part of the parenchyma where the inflammatory reactions have already set in. The apparently decreased virulence of the bacillus and the sustained defensive immunological body mechanisms are more often able to prevent further intrabronchial spread of the disease.

Five months later there was again a notable improvement manifested by considerable resorption of the infiltration in the right lung field, and regression of the lesions in the left lung. The small cavities disappeared and the large cavity in the left upper lobe decreased in size.

Case viii. This twenty-two year old white male gave a history of active tuberculosis for the past two years. A first stage left thoracoplasty was performed one year prior to the present admission. However, the thoracoplasty was not completed because the patient left the hospital against medical advice. During the last month the patient had a productive cough, recurrent hemoptysis, dyspnea, fever, anorexia and sharp chest pain.

Physical examination revealed a severely ill patient, who was extremely cyanotic and dyspneic, requiring constant oxygen inhalation. The sputum was positive for tubercle bacilli.

Roentgen examination of the chest showed large confluent cavities replacing practically completely the parenchyma of the left lung. Throughout the right lung, there were disseminated gross and small nodular foci of infiltration, which were lobular in character in the infraclavicular portion of the upper lobe and confluent in other areas.

The patient was placed on streptomycin daily without much hope of altering his course. However, the improvement following the administration of this drug was unexpected and remarkable. The temperature returned to normal within two weeks, the dyspnea subsided, and he was able to get along without oxygen. The patient's appetite improved steadily, and he gained 20 pounds within a month.

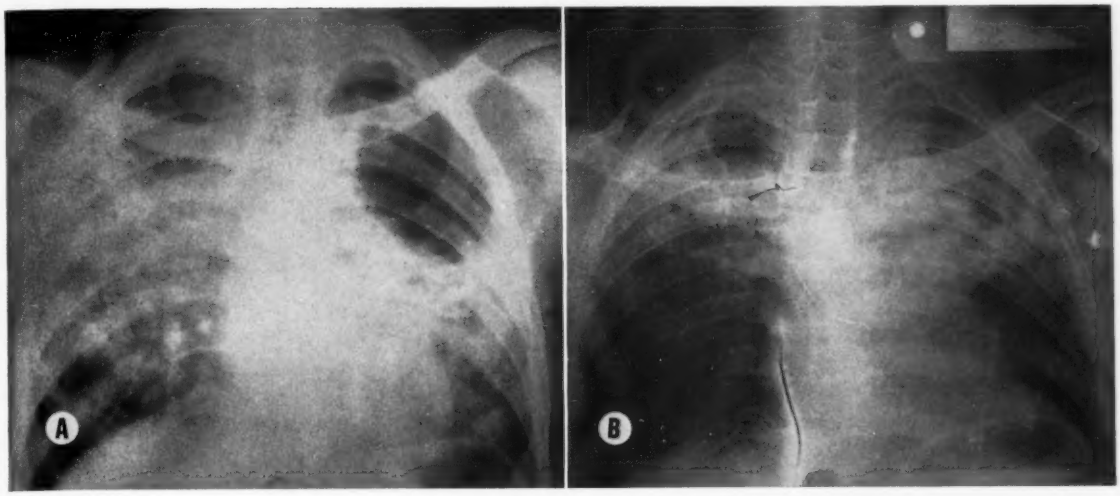

Fig. 7. Case vii. (*A*) Film on admission. (*B*) Five months after beginning streptomycin therapy.

Re-examination three weeks later showed marked regression of the infiltration in the right lung. The process was now limited largely to the infraclavicular area of the right upper lobe in which the initial lesion was of the confluent lobular or bronchopneumonic type. The lower portion of the right lung field was essentially clear except for some accentuation of the pulmonary markings. The left lung field remained roentgenologically "stable." The patient again left the hospital against medical advice.

It is obvious that no conclusions can be drawn as to the further progress of lesions of this type. Stabilization of the disease is extremely difficult in such cases, and even marked regressions may prove only temporary. The ultimate course depends on many factors, some of which we mentioned previously. It is certain, however, that the extent of involvement plays a tremendous role in determining the clinical prognosis in each case of tuberculosis, and streptomycin does seem to offer definite advantages even in serious cases of advanced fibrocaseous disease. While it does not suffice as a therapeutic agent, it aids considerably under certain circumstances in limiting the disease.

C. Tuberculous Pneumonia. Tuberculous pneumonia presents essentially the same pathological alterations as a small lobular lesion, except that the probability of complete resorption of the inflammatory exudate is much less. As a rule, the process

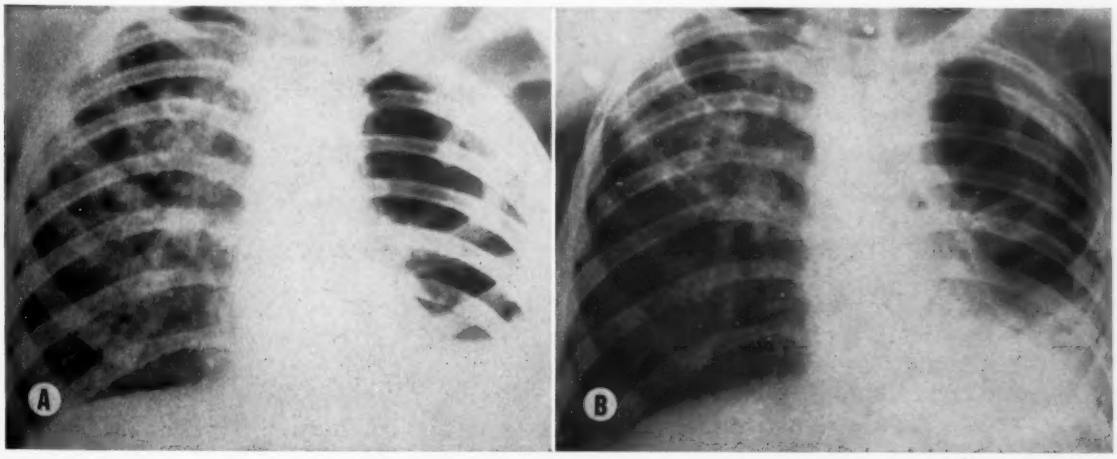

Fig. 8. Case viii. (*A*) Film on admission. (*B*) Three months after beginning streptomycin therapy.

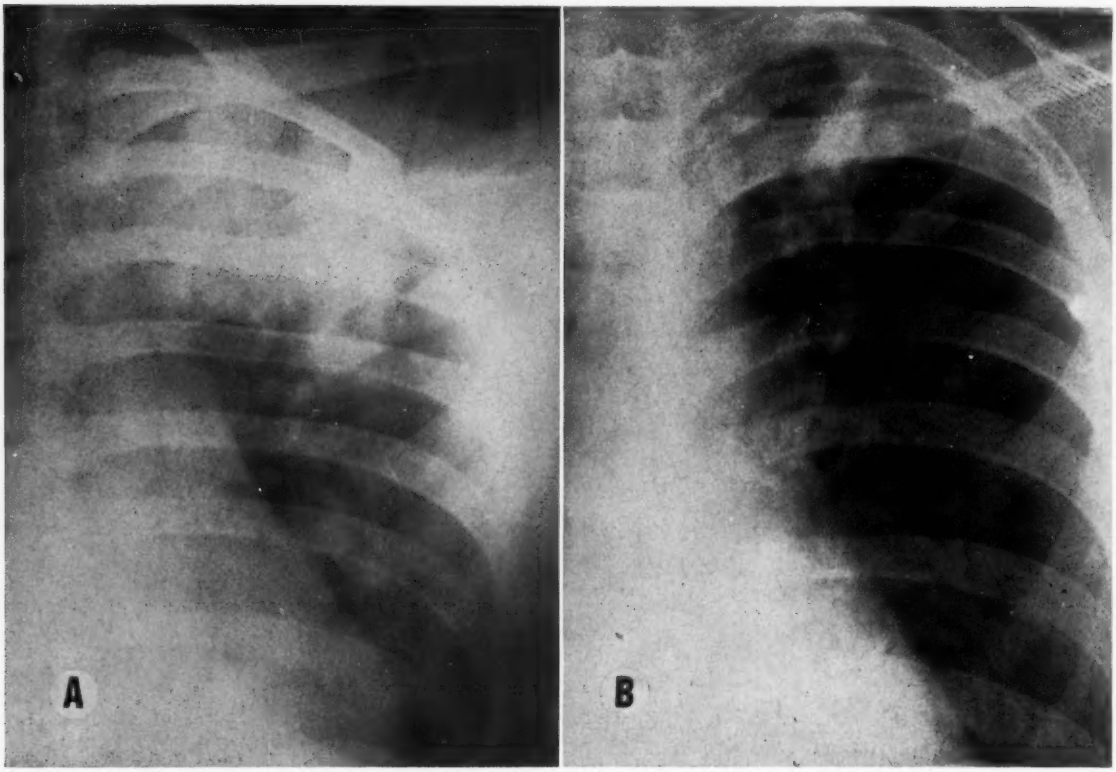

Fig. 9. Case ix. (*A*) Film on admission. (*B*) Six months after beginning streptomycin therapy.

goes on to varying degrees of caseation and its sequelae. Immunological factors determine the eventual course. The response of tuberculous pneumonias to streptomycin is less satisfactory than in cases with purely exudative lesions. However, even in such cases the effect which may be obtained warrants the use of the drug.

Case ix. This twenty-four year old white male was admitted because of severe hemoptysis of three days' duration. Sputum examination was positive for tubercle bacilli.

Roentgen examination of the chest showed a large area of consolidation involving a part of the left upper lobe and fine mottling in the lower lung field which was thought to represent dissemination of the tuberculous process.

The patient was placed on streptomycin for four months. He improved subjectively very rapidly at first, and then more gradually. The temperature returned to normal within three weeks, and the sputum was converted from positive to negative within five weeks. The sedimentation rate returned to normal within three months.

Serial roentgen studies of the chest showed a striking improvement manifested by gradual resorption of the pneumonic consolidation. Eventually, only a small residual focus of increased density remained, which presumably was the original focus which gave rise to a new exudative lesion, and the acute exacerbation at the time of admission. The hemoptysis certainly must have been due to tissue destruction, and not only inflammatory exudation. However, the secondary pneumonia did not show a rapid progression toward caseation. On the contrary, with bed rest and streptomycin, resorption dominated the pathological process. This resulted in apparent restitution of the parenchyma as far as the new process was concerned.

Case x. A Mexican male, aged twenty-seven, was admitted with a cough productive of purulent sputum and fever of one week duration. The temperature was 103° F. The sputum examination was positive for tubercle bacilli.

Roentgen examination of the chest showed a consolidation of the right upper lobe with a central infraclavicular cavity, demonstrated by laminagraphy. A confluent bronchopneumonic

infiltration was present in the right middle lobe.

The patient was placed on streptomycin, whereupon the temperature returned to normal within three weeks. The patient gained weight, and felt better subjectively.

Serial roentgen studies of the chest showed a gradual regression of the parenchymal lesions. Areas of reaerated lung could be observed, and the uniform consolidation was replaced by more patchy lobular densities. The cavity did not change significantly at first. However, four months after institution of treatment the disease was limited to the right upper lobe; and the cavity was smaller and its wall thinner. There was no contralateral spread.

Case xi. This twenty-eight year old colored female had recurrent hemoptysis, fever and cough. The sputum was positive for tubercle bacilli.

Roentgen examination of the chest showed pneumonic consolidation of the right upper lobe within which several small cavities were discernible.

The patient was placed on bed rest and streptomycin, following which she initially showed a satisfactory improvement. There was partial resolution of the pneumonic consolidation within one week. Subsequent serial films showed, however, a recurrence of the consolidation with rapidly progressing enlargement of the cavities which also increased in number. It was apparent that the administration of streptomycin did not prevent the caseation from further progression to liquefaction and cavitation. Even a temporary stabilization of the disease could not be obtained. One must therefore assume, in contrast to other cases, that this particular infection was more severe and the defensive mechanisms inadequate, even with the aid of the drug, to prevent the disease from further progression. The relationship between the quantitative extent of the disease and its qualitative reactions are thus again emphasized. There undoubtedly is a parallelism between the extent of the disease and the organic response to the infection.

Case xii. This thirty-one year old male had a cough, malaise, fever, and chest pain of about

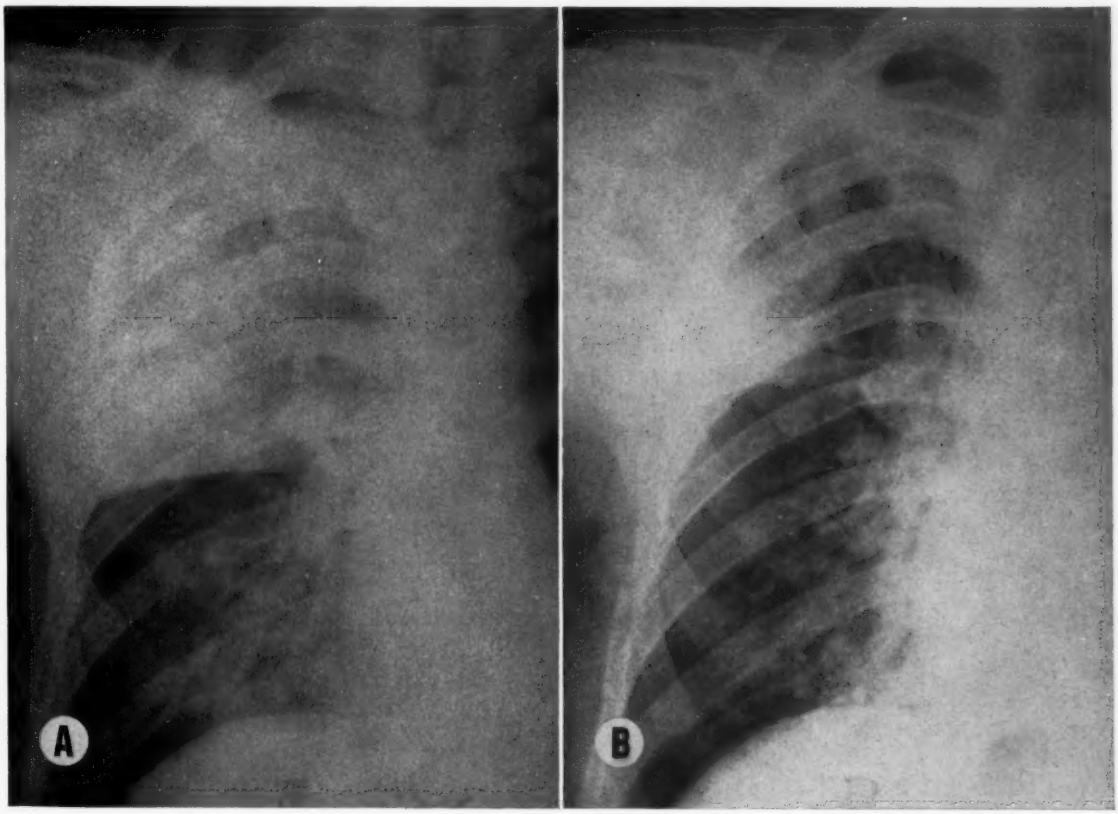

Fig. 10. Case x. (*A*) Film on admission. (*B*) Five months after beginning streptomycin therapy.

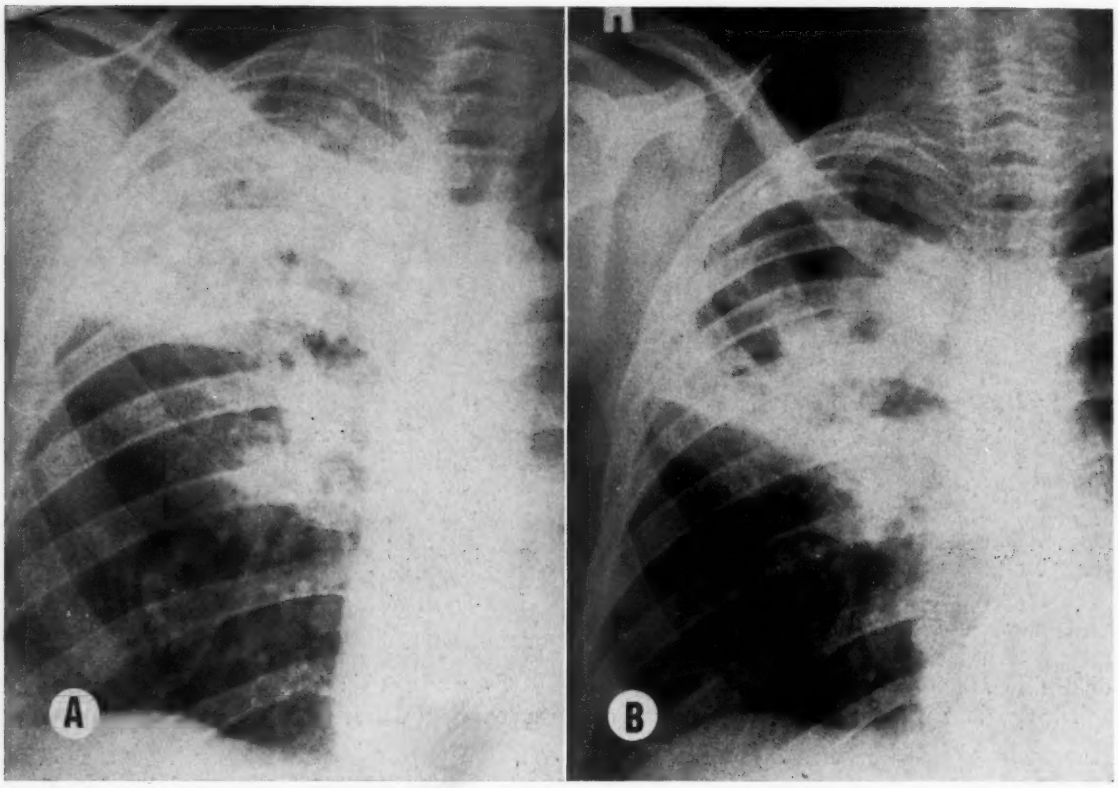

FIG. 11. Case XI. (*A*) Film on admission. (*B*) Three months after beginning streptomycin therapy.

one month duration. The sputum was positive for tubercle bacilli.

Roentgen examination of the chest revealed pneumonic infiltration of the right upper lobe with numerous central cavities. There was also a recent less extensive pneumonic infiltration in the right middle lobe. The left lung field was clear.

The patient improved subjectively within three weeks after the administration of streptomycin. The temperature dropped from 103° F. to normal.

Serial roentgen studies showed considerable resolution of the pneumonic process in the right upper lobe three weeks after institution of streptomycin therapy, and complete clearing of the right middle lobe. The cavities increased in size and were surrounded by zones of residual parenchymal infiltration. While the patient was still receiving streptomycin, a bronchogenic spread to the lingula of the left upper lobe occurred. On continued therapy, the infiltration in the right upper lobe regressed further. There were numerous, nodular, fairly sharply defined foci at the site of the previous consolidation. There was some decrease in the size of the cavities four months after admission. The exudative lesions in the lingula regressed slightly.

In this case the initially satisfactory progress of the disease was modified by a new parenchymal lesion affecting the contralateral lung. This is of great clinical significance, since it alters the general prognosis and influences the treatment in an adverse manner. The occurrence of such a dissemination, in spite of active streptomycin therapy, serves to emphasize that the effectiveness of the drug is limited. When a hyperergic state exists, the suppressive action of streptomycin may prove insufficient to prevent further dissemination of disease to uninvolved areas of pulmonary parenchyma in spite of the apparent healing of older lesions. This, of course, indicates that the pathological process is not progressing uniformly in one direction. On the contrary, the process of repair and destruction may exist concurrently until eventually one dominates the clinical picture. Here, too, the extent of

the initial involvement appears to have a bearing on the course of the disease.

D. Productive (Fibroid) Tuberculosis. Although productive lesions are usually distinguishable roentgenologically, they are frequently intermixed with exudative lesions. Assmann has for this reason cautioned against a too ready application of the terms "productive" and "exudative," stating that in the majority of cases productive and exudative processes are going on side by side in the same tuberculous focus, and cannot be separated from one another by the naked eye. Gräff and Küpferle[4] recognized the impossibility of making too sharp a distinction between these two fundamental forms and spoke of "mainly productive" or "mainly exudative" lesions.

The pathological character of productive focal lesions is such that they were not considered to represent a group responding favorably to streptomycin. However, we have observed some clinical and roentgenologic improvement in cases of this type in which the drug was used primarily because of complicating tuberculous laryngitis.

Case XIII. This sixty-one year old white male, who was previously treated for chronic pulmonary tuberculosis, had had recurrent bouts of hemoptysis for the past four months. At the same time hoarseness and dysphagia also became manifest. The sputum was positive for tubercle bacilli. Laryngoscopy showed evidence of an ulcerative tuberculous laryngitis.

Roentgen examination of the chest showed a diffuse, small, nodular infiltration throughout the upper two-thirds of both lung fields. The small nodulations were separated by areas of translucent lung tissue. In certain areas, the periphery of the nodules was blurred, irregular and poorly defined.

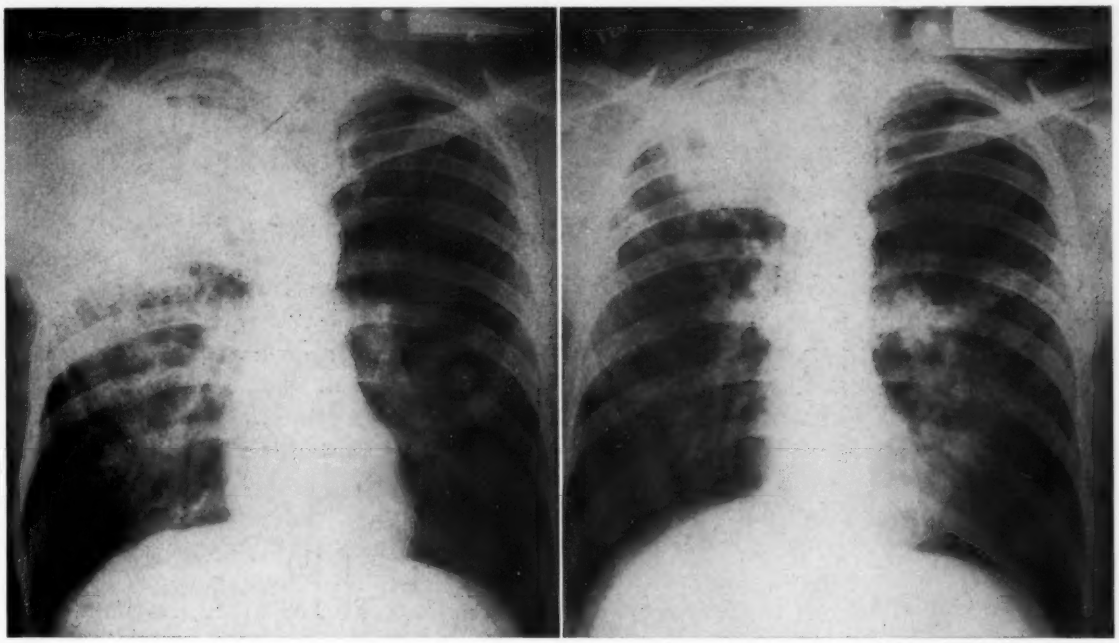

Fig. 12. Case XII. (*A*) Film on admission. (*B*) Four months after beginning streptomycin therapy.

Following streptomycin his laryngeal symptoms improved considerably. A slight residual hoarseness persisted, but the patient's dysphagia disappeared completely.

Serial roentgenograms of the chest failed to disclose any significant change during the first three months of streptomycin therapy. No patho-anatomical alterations of the pulmonary lesions were actually expected. However, approximately six months after the initial examination a definite improvement of the pulmonary lesions was noted. The area of the original infiltration decreased considerably. Individual nodules disappeared completely in large segments of the lung, and those which remained were smaller in size and more sharply defined.

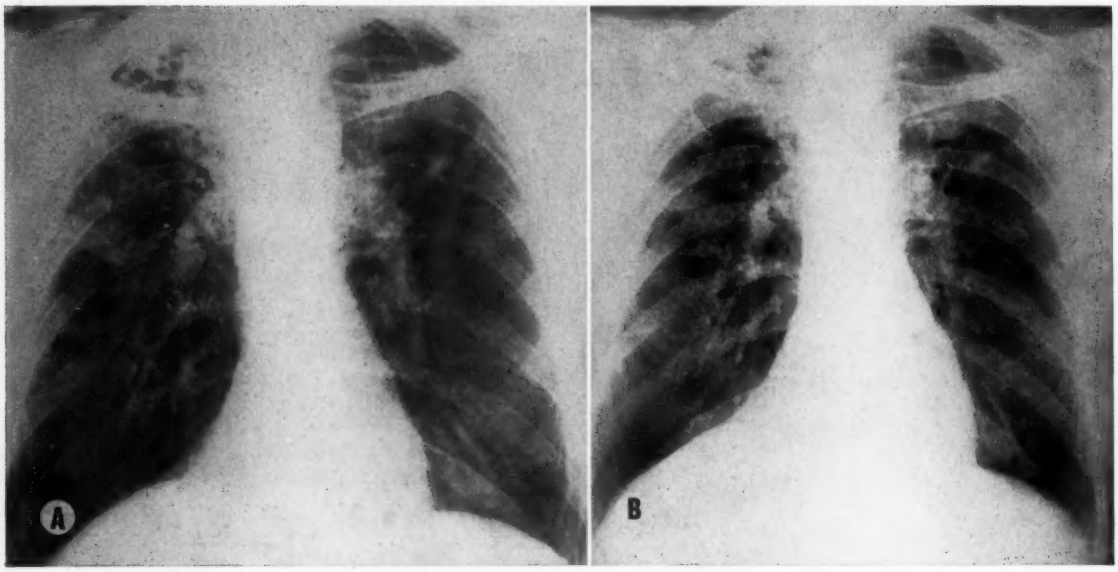

Fig. 13. Case xiii. (*A*) Film on admission. (*B*) Six months after beginning streptomycin therapy.

It was our impression that this case, as well as a few other similar cases, has shown not only a clinical improvement, but also an anatomical regression of the original productive lesions. Such findings support the contention that the ultimate prognosis in productive lesions, which are commonly associated with exudative phenomena, depends on their successful fibrosis rather than on the formation of granulation tissue. It is reasonable to assume that the delayed roentgenologic improvement is due to the factors which favor or impede the action of streptomycin on the tubercle bacillus, among which the tissue reaction plays an important role. Productive lesions undoubtedly present a strong barrier to streptomycin, which delays adequate tissue concentration. Also, greater tissue concentration may be required in productive lesions than in exudative lesions. Here, too, streptomycin seems to affect primarily the exudative phase of the disease, rather than alter the lesions which are already in part fibrosed. Progression of the disease may be arrested by preventing further exudation and caseation. It is also very likely that the control of secondary tuberculous lesions, such as laryngeal tuberculosis, decreases the density of the infection.

We are not convinced, on the basis of roentgenologic observations alone, that the disappearance of focal lesions is synonymous with their anatomic healing, not even when repeated sputum examinations are negative. We hesitate to make such an assumption because of the common experience with miliary tuberculosis in which the lesions are frequently not detectable roentgenologically for some time. It is quite possible that here, too, it is not the miliary tubercles which cast shadows on the roentgen film, but rather the exudative and caseating foci which accompany miliary tuberculosis.

Similar observations were also made in cases in which the exudative component of the disease process was more pronounced. It may be stated that the roentgenologic improvement was largely dependent on the degree of recent exudation in a disease which, though it had gone on to granulation tissue formation, failed to heal satisfactorily by secondary fibrosis and calcification. Obviously in such cases caseation may ensue resulting in further progression of the disease, and thus lead to the formation of cavities which are essentially identical with those occurring in fibrocaseous tuberculosis. In cases of this type,

the therapeutic response to streptomycin is not spectacular, but some improvement can be observed after a prolonged period of treatment.

Case xiv. A white male, aged seventy-two, had a chronic cough for several years. The patient complained of moderate shortness of breath on exertion which grew progressively worse for the last year. The sputum examination was positive for tubercle bacilli.

Roentgen examination of the chest revealed a diffuse nodular infiltration throughout the upper two-thirds of both lung fields, a somewhat larger area of infiltration in the right infraclavicular area with a central cavity confirmed by laminagraphy, and pleural reaction in the left apex.

Thereupon the patient received streptomycin for a period of three months. Symptomatically he improved considerably during the first two months. However, the sputum remained positive, and no improvement was evident roentgenologically.

Serial roentgen studies showed a more definite cavity in the right upper lobe and some resorption of the surrounding infiltration. The nodular lesions did not change significantly. Six months after admission the nodular infiltrations decreased in size; they became more widely separated by normal intervening parenchyma, and showed a somewhat more distinct "reticular" pattern. Although the cavity failed to close, there were no new exudative foci, and the disease had apparently assumed a more stable character. Although it cannot be said that the disease had become arrested, the exudative component, which was not very apparent from the roentgenograms, subsided to an extent which seemed to justify the administration of streptomycin.

Case xv. This white male, aged seventy-six, had a chronic pulmonary tuberculosis for ten years. Six weeks prior to admission, his cough became more severe and productive of larger amounts of purulent sputum. Hoarseness and moderate dysphagia also developed. Laryngoscopy revealed ulcerative tuberculous laryngitis.

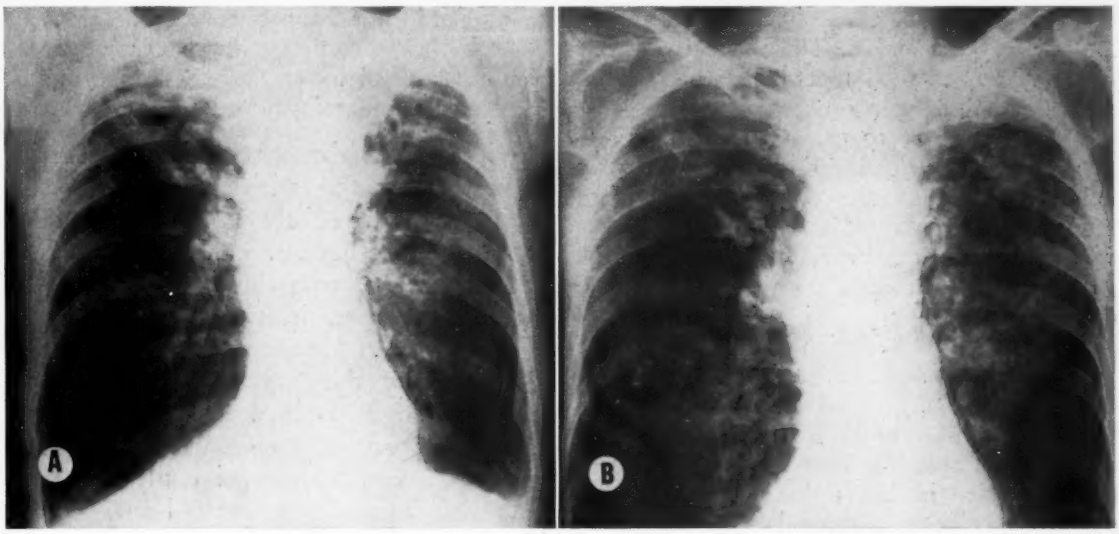

Fig. 14. Case xiv. (*A*) Film on admission. (*B*) Six months after beginning streptomycin therapy.

Laboratory studies showed a red cell count of 4.2 million, 80 per cent hemoglobin, and a white blood cell count of 7,000, with 58 per cent polymorphonuclears, 41 per cent lymphocytes and 1 per cent eosinophils. The sedimentation rate was 23 mm. per hour. The sputum contained tubercle bacilli.

Roentgen examination of the chest showed disseminated, fibrocalcific foci in both apices and recent exudative lesions in the left parahilar area and at the right base, which suggested recrudescence of active pulmonary disease within an old isolated focus.

The patient noticed moderate subjective improvement within six weeks after the ad-

ministration of a divided dose of 1.5 gm. of streptomycin daily.

Re-examination of the chest seven weeks after institution of treatment showed some regression of the pulmonary exudative lesion on the left and complete clearing of the right base. Within the partly resolved infiltration on the left, several older foci could be discerned, which had become more sharply delineated.

During the thirteenth week of treatment the patient suddenly had an attack of hematemesis accompanied by petechiae of the legs and feet, air hunger and shock. Blood studies at that time revealed a red cell count of 1.8 million with 4.2 gm. of hemoglobin. The white blood cell count was 2,700 with 1 per cent polymorphonuclears and 99 per cent lymphocytes. The platelet count was 53,000 and the hematocrit 10 per cent. The clotting time was three and a half minutes, and the bleeding time three minutes. Despite blood transfusions and general supportive therapy, the patient died within six hours after the onset of this acute episode.

Postmortem examination revealed a massive gastrointestinal hemorrhage. The gastric mucosa showed many petechiae and ecchymoses with no evidence of local erosion. The bone marrow was aplastic. There were several calcified nodules in the right upper lobe and numerous calcified nodules in the left upper lobe. On cut sections of these nodules, there was considerable caseous material within the central portions surrounded by calcific material. In the upper portion of the left lobe there was a calcified nodule full of caseous material which measured 1.5 cm. in diameter. The larynx showed fibrotic, contracted vocal cords. Microscopic sections of the lung in those portions which showed fibrocaseous tuberculosis grossly, revealed large necrotic areas surrounded by fibrocalcareous material. The usual tuberculous reaction was not seen, but instead there were large sheets of fibrous tissue with a few lymphocytes. No Langhans' giant cells were present. Smears of the necrotic caseous material revealed numerous tubercle bacilli. Sections of the larynx revealed the submucosa to contain many hard, small tubercles without areas of caseation and some small focal areas of caseation surrounded by epithelioid cells, lymphocytes and Langhans' giant cells.

This case is the only one in our series thus far, treated with streptomycin, in which the toxic effects of the drug were of such a serious nature. The drug did affect favorably a new pulmonary infiltration which developed in the periphery of a partly calcified fibrocaseous focus. The tuberculosis of the larynx was less severe than it usually is in advanced cases, because the process was largely productive and there was no extensive ulceration or necrosis. The discrepancy between the laryngoscopic findings on admission and those on postmortem examination was probably due to the therapeutic effect of streptomycin.

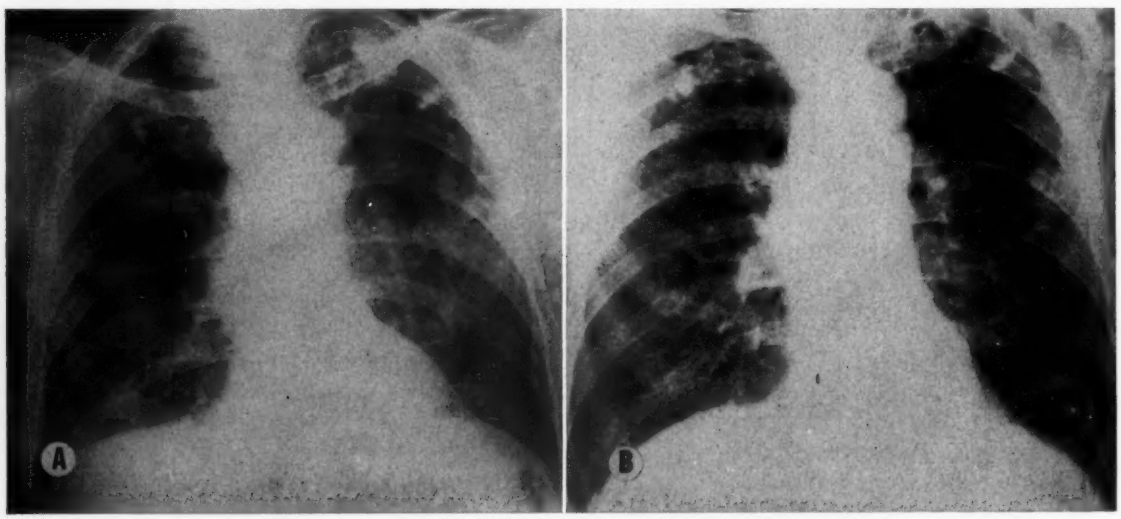

FIG. 15. Case XV. (*A*) Film on admission. (*B*) Three months after beginning streptomycin therapy.

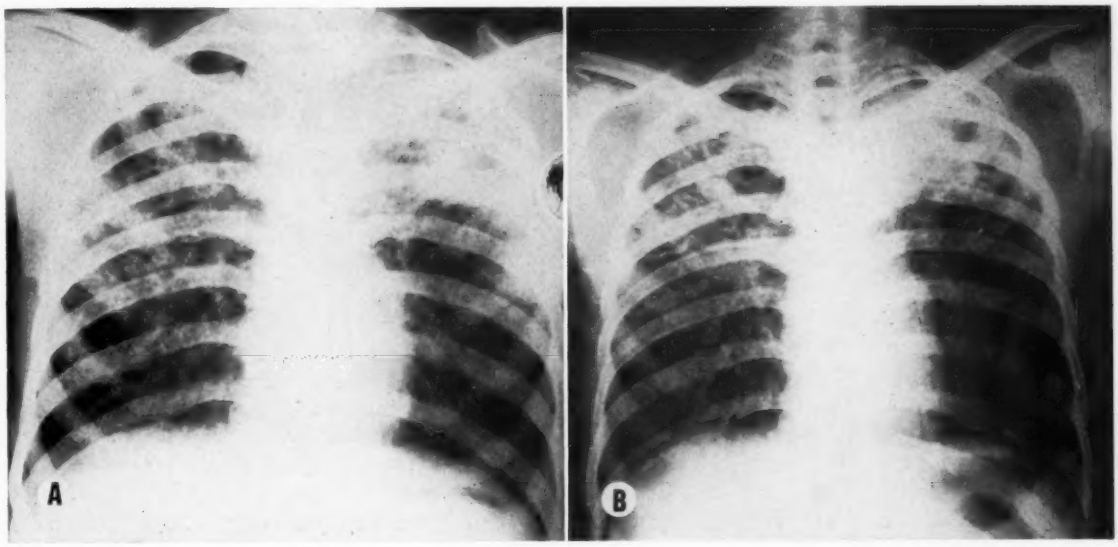

Fig 16. Case xvi. (*A*) Film on admission. (*B*) Five months after beginning streptomycin therapy.

E. Non-miliary Hematogenous Dissemination. The clinico-roentgenological diagnosis of hematogenous dissemination is usually based on certain distribution patterns of demonstrable lesions, which suggest that they have been produced by hematogenous dissemination of the bacilli. Pathological proof of such an assumption is rarely possible. This is in part due to the fact that bronchogenic aspirations are almost invariably present, and that possible sources of hematogenous foci are not always recognizable. Hübschmann emphasized that hematogenous miliary tuberculosis produces intra-alveolar lesions in which either the exudative or productive components may predominate. The primary localization of miliary foci is not interstitial as older concepts have assumed.

The predominantly exudative miliary (hematogenous) foci represent in essence small, circumscribed, exudative areas, surrounding small, caseating foci, which are not distinguishable from bronchogenic disseminations.

This is also evident from the observations of patients treated with streptomycin. Lesions which could be presumed to fulfill the criteria of hematogenous dissemination were so often attended by exudative phenomena, which responded to this form of therapy, that the anatomical support in favor of the concept of non-alveolar disease was lacking. Once the alveolar process is admitted, the bronchogenic route of dissemination cannot be denied. Redeker and Walter,[11] *e.g.*, called attention to the pseudomiliary dissemination, which occurs in cases of infraclavicular infiltrations, especially when they caseate and form cavities. These disseminations are roentgenologically indistinguishable from hematogenous tuberculosis.

Two of our cases are perhaps representative of this group, and their response to streptomycin was interesting.

Case xvi. This Mexican male, aged twenty-three, had an active, pulmonary tuberculosis of at least one year duration. One month prior to admission he developed hoarseness, severe dysphagia, fever, weakness, and loss of weight. The sputum was positive for tuberculosis. Laryngoscopy disclosed tuberculosis of the larynx.

Roentgen examination of the chest revealed fibrocaseous tuberculosis of the left upper lobe with a large infraclavicular cavity containing fluid. Throughout both lungs there was a diffuse nodular infiltration, which was separated by normal intervening parenchyma in some areas, but in many other areas was coalescent and formed large nodular foci. There was a thin walled cavity in the right second intercostal

space. Numerous small irregular areas of increased translucency suggestive of multiple "hematogenous" cavities were present in both lung fields. The patient was placed on streptomycin both intramuscularly and by aerosol. Within approximately two months the temperature returned to normal, he gained weight, and the laryngeal symptoms improved considerably.

Serial roentgen studies of the chest showed a gradual disappearance of the pneumonic infiltration in the left upper lobe. This was replaced by several coalescent cavities which later decreased in size. Several larger exudative foci could be demonstrated in the right upper lobe, but these, too, gradually subsided. The small disseminated nodular lesions remained fairly stationary for some time, but approximately five months after the administration of streptomycin was instituted, a definite regression could be observed. The nodules became more sharply outlined, smaller in size, and their contours became more regular. The patient was then transferred to another hospital for further treatment.

A dynamic reconstruction of the pathological evolution in this case suggests that an infraclavicular infiltration caseated, produced a cavity and then spread bilaterally either by the hematogenous route, or by bronchogenic aspiration. The distribution and morphological character of the lesions, as well as the presence of tuberculous laryngitis, were compatible with a hematogenous dissemination. However, the lesions were predominantly exudative in nature, and thus regressed following streptomycin therapy. Pseudomiliary bronchogenic dissemination is another possibility which cannot be distinguished from very similar hematogenous lesions.

CASE XVII. This thirty-four year old white female had chronic pulmonary tuberculosis of five years' duration. The sputum contained numerous tubercle bacilli.

Roentgen examination at the onset of the disease showed a cavity in the apex of the right lower lobe, with bronchogenic spread to the right base.

An attempted pneumothorax had to be discontinued because of excessive fluid within the pleural cavity. In spite of this, she became apparently well stabilized until two years before admission, at which time she suddenly began to lose weight and developed fever up to 103° F. Roentgen examination of the chest at this time showed a diffuse miliary infiltration throughout the upper two-thirds of both lung fields. There was no evidence of a cavity in the right lower lobe.

She was placed on bed rest, with some symptomatic improvement. Several months later continuous progress of the disease was manifested by the appearance of several thin walled cavities in the right upper lobe.

The patient was re-admitted to the hospital eighteen months later. At this time she also had symptoms strongly suggestive of renal tuberculosis, but no bacilli were recovered from the urine either on culture or inoculation. She was placed on streptomycin following which the urinary symptoms subsided completely. Her general systemic symptoms also improved a great deal.

Serial roentgen studies of the chest following her last admission showed a gradual regression of the "miliary" infiltration in both lung fields. In both upper lobes there remained several small cavities and infiltrative foci which, however, representated patterns more consistent with fibrocaseous tuberculosis than those of hematogenous origin.

In this case, too, the sequence of events can be fairly well reconstructed. A "typical" tuberculous infiltration led to cavity formation. An adequate collapse therapy was prevented by subsequent pleural effuf sion and pleural adhesions. Exacerbation o- the disease manifested itself clinically by the disease manifested itself clinically by bilateral miliary dissemination, which, roentgenologically at least, did not seem to be attended by predominant exudation. However, necrosis did occur and multiple cavities appeared in the right upper lobe. The urinary symptoms were strongly suggestive of urinary tract tuberculosis.

Streptomycin was apparently able to control the disease to the point that the process regressed considerably, even after this long interval, and became limited to the upper lobes only. The limited regression of the latter lesions is not an infrequent experience in pulmonary tuberculosis. Streptomycin does not seem to affect definitely the older "apical" lesions. Redeker and Walter[11] attributed this mani-

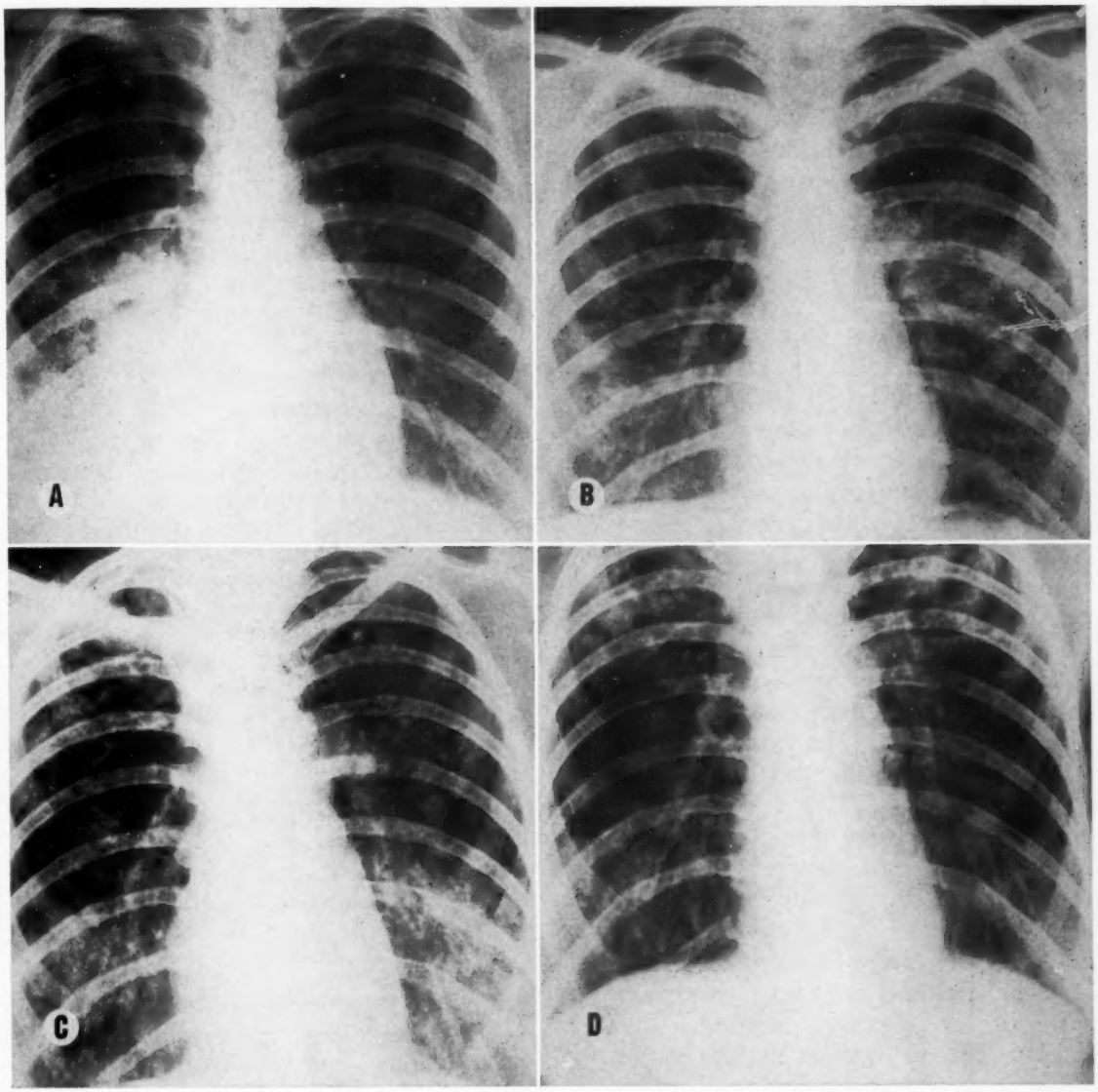

Fig. 17. Case xvii. (*A*) The original lesion. (*B*) Two years later. (*C*) Five years later, at the time of streptomycin therapy. (*D*) Five months after treatment.

festation to co-existent involvement of the pleura. The more or less extensive pleural adhesions prevent cavities from collapsing, and thus the infection is maintained over prolonged periods of time.

SUMMARY

1. One hundred and eighty-seven cases of pulmonary tuberculosis treated with streptomycin have been reviewed. The clinical and roentgenological aspects have been compared and correlated.

2. In conformity with the experiences of other investigators it was noted that the chief value of the drug lies: (a) in its ability to cause significant symptomatic improvement in all cases so treated, and (b) in the effect it exerts on exudative lesions regardless of whether exudation dominates the clinical picture or accompanies caseous or fibrocaseous lesions.

3. The therapeutic effect of streptomycin is limited by drug fastness, which developed in a great majority of cases.

4. The conventional roentgenologic classification of individual tuberculous le-

sions is not accurate since the distinction between exudative non-caseous and caseating lesions is not possible. The only reliable roentgenological evidence of caseation is the appearance of cavities within areas of pneumonic infiltration.

5. Productive lesions are frequently accompanied by peripheral exudates which are not always large enough to be distinguished roentgenologically. The progression of a productive focus, however, is inseparable from an initial exudative phase.

6. Exudative lesions in areas of recent exacerbation usually resorb completely under streptomycin therapy. Small residual infiltrations almost invariably represented older foci, from which the new exacerbations recurred. This is in keeping with the modern concept of evolution of pulmonary tuberculosis, as opposed to the older view of a continuous apicocaudad progression.

7. The administration of streptomycin in fibrocaseous and productive tuberculosis is useful only to the extent that it usually limits the disease to the parenchyma already involved. The exudative lesions accompanying these forms of tuberculosis also absorb, though less promptly than in the predominantly exudative phase. In some cases, however, bronchogenic spreads may occur in spite of continued treatment.

8. Tuberculous cavities may appear in spite of streptomycin therapy. Cavities are usually seen in tuberculous pneumonias, which have progressed to caseation. This is not usually modified by the drug.

9. Cavities frequently decrease in size and, when isolated, may completely disappear. This is due in part to alleviation of bronchostenosis and in part to the process of repair which may eventually leave a scar at the site of the cavity.

10. Streptomycin represents a useful adjunct to the accepted methods of treatment in pulmonary tuberculosis, but alone it is not a method of definitive therapy.

11. Prophylactic use of streptomycin aimed at obviating such complications as empyema and bronchopleural fistulae may prove helpful in extending the field of surgical treatment of tuberculosis.

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Vol. 67, No. 3

UNUSUAL CAUSES OF RIB NOTCHING*

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and

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FOR MANY years notching of the ribs was thought to occur only with coarction of the aorta, but more recently it has been shown to occur in other diseases as well. The purpose of the present article is to review the known causes of rib notching and to add two more to the growing list of conditions which can produce it.

REVIEW OF LITERATURE

Coarction of the aorta remains, by far, the most common cause of rib notching. Rösler,[11] in 1928, first described notching of the ribs in this condition. Since this time many other writers have confirmed his findings and it is now known that rib notching is found in about three-fourths of the cases of coarctation.[8,10,12]

In 1937, Laubry and Heim de Balsac[7] described 5 cases of rib notching in which coarctation of the aorta was absent. These included 2 cases of arterial hypertension with aortic valvular disease, 1 case of luetic aortitis with aortic regurgitation, 1 case of valvular heart disease of unknown origin, and 1 case of mitral stenosis with endocarditis. In this article the case reports were brief and no autopsies were performed, so that the mechanism of the rib notching was neither proved nor apparent.

Dussaillant *et al.*,[4] in 1945, reported a case of unilateral rib notching in the absence of coarctation of the aorta in which arterial hypertension, generalized arteriosclerosis, and senile emphysema were present. No pathologic study was made.

In 1948, Batchelder and Williams[2] reported a case of unilateral notching of the left ribs in a thirty-eight year old male. Autopsy revealed the presence of dilated, tortuous intercostal arteries on the left associated with the tetralogy of Fallot. Barden[1] has seen a similar case.

Benign tumor masses such as intercostal neurofibromata in von Recklinghausen's disease have been known to cause rib erosions which are, roentgenologically, similar to vascular erosions.[5]

MECHANISM OF RIB EROSION

In coarctation of the aorta, localized erosions of the inferior border of the ribs are usually ascribed to abnormalities of the intercostal arteries. The roentgenographic findings are therefore variable both in the degree and extent of the involvement, although the more typical case shows bilateral notching extending from the third to the tenth ribs, inclusive. However, if the constriction occurs proximal to the left subclavian artery, unilateral notching of the ribs of the right hemithorax may be expected. The arterial injection studies of Bramwell and Jones demonstrated that the primary factor in the development of rib erosions in coarctation of the aorta is the tortuosity of the dilated intercostal arteries, resulting from increased blood flow. The varying degree of tortuosity of the arteries carrying the collateral circulation produces unpredictable patterns of rib notching and, if the tortuosity is slight, notching will be absent.

In some cases of the tetralogy of Fallot, the intercostal arteries may anastomose with the mediastinal arteries and become dilated and tortuous. The anastomosis results in a bypassing of the stenotic pul-

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monary valve and along with the bronchial arteries constitutes part of the collateral circulation to the lungs.[6]

Localized intercostal arterial dilatation and tortuosity not associated with coarctation of the aorta can also produce notching. Case II is an example of this. The exact pathology of the arterial abnormality has not been determined. Rib notching caused by dilated tortuous venous channels has not previously been reported. Case I is an example of this cause of rib notching with antemortem and postmortem proof.

It is difficult to explain the mechanism of the rib erosions in the cases cited by Laubry and Heim de Balsac and by Dussaillant *et al.* It is conceivable that in some of these cases the combination of arteriosclerosis and a wide pulse pressure from hypertension or aortic insufficiency resulted in unusually forceful pulsations of tortuous intercostal arteries against the ribs. In the remaining cases no explanation can be offered from the information available.

In other cases, also, the cause of rib notching may not be apparent. One of us (F.A.B.), in a chest survey of 275,000 Army inductees, has seen 6 cases of well established notching of the ribs in which the history and physical examination revealed no significant abnormalities.

FIG. 1. Case I. Infra-red photograph, demonstrating extensive superficial collateral circulation.

REPORT OF CASES

CASE I. A male, aged fifty-nine, was admitted on March 20, 1949, for terminal care because of a far-advanced squamous carcinoma of the face.

Past history disclosed the presence of large varicosities of the wall of the chest and abdomen since childhood. These appeared after a severe febrile episode of approximately one month's duration. Scarlet fever was suspected. Thereafter, the patient led a normal and unrestricted life until the onset of the malignancy. The varicosities of the trunk were noted and studied at the time of military service in 1917, but these records are not available.

Physical examination revealed a far-advanced malignant ulcer of the face with extensive local lymph node metastasis. Varicosities up to 1.2 cm. in diameter were noted over the thorax and abdomen, extending from the clavicular to the inguinal regions (Fig. 1). At all times the blood flow in these veins appeared to be in a caudal direction. The thighs and legs were uninvolved. The heart, lungs, and abdomen revealed no abnormality except that the liver was palpable just below the right costal margin. The blood pressure was 120/80 in both arms.

Laboratory studies were essentially normal, with the exception of a red blood cell count of 3.5 million and a hemoglobin of 10.5 grams. The vital capacity was 3.2 liters. Venous pressures in the antecubital veins were 260 and 255 mm. of saline, right and left respectively. The venous pressure in the right femoral vein was 50 mm. of saline.

Chest roentgenograms revealed multiple nodular metastases, marked notching of the right sixth and eighth ribs, and minimal notching of all the other ribs from the third to ninth, inclusive (Fig. 2). In the superior mediastinum there were several calcifications, the largest of which measured 3.0 cm. in diameter. These were partially superimposed over the shadow of the aortic arch and lay anterior and lateral to the trachea.

Phlebograms were obtained by injection of

50 cc. of 70 per cent diodrast into the right median basilic vein on March 25, 1949, and by the simultaneous injection of 35 cc. of 70 per cent diodrast into the right and left antecubital veins on March 28, 1949. These showed a complete block of both innominate veins just distal to the expected origin of the superior vena cava, and immediately adjacent to the several large mediastinal calcifications. Many dilated anastomotic veins arising from the large venous trunks of the upper thorax were demonstrated, including all named branches of the subclavian veins, the internal mammary, the subscapularis with its long thoracic extension, and several large intercostal veins (Fig. 3). It was noted that the loops of the dilated tortuous intercostal veins, particularly the right sixth, had produced erosions of the ribs.

The hospital course was one of progressive advancement of the neoplasm, with death occurring on July 13, 1949.

Autopsy revealed a dense fibrocalcific mass in the anterior superior mediastinum which on gross inspection appeared to be inflammatory and not neoplastic. Each innominate vein terminated in this mass as a smooth rounded pouch. The superior vena cava was completely obliterated except for a blind pouch, 2 cm. long, protruding from the right auricle. The identity of the obliterated vena cava and the termination of the innominate and azygos veins were lost in the fibrocalcific mass. From the veins normally drained by the superior vena cava large deep and superficial anastomotic collateral trunks arose and joined the tributaries of the inferior vena cava. The superior vena cava was approximately twice normal size and was the only patent vessel entering the right auricle. Local dissection in the region of the rib notching showed dilated tortuous veins, but normal arteries.

Microscopic examination of the mass in the superior mediastinum showed nonspecific scarring and calcification with no evidence of neoplasm.

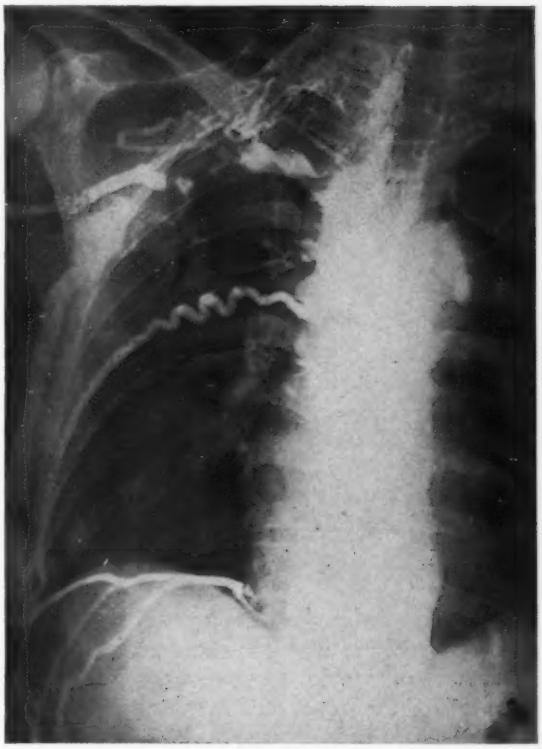

Fig. 3. Case 1. Venogram, showing deep collateral circulation. The loops of the enlarged tortuous intercostal vein can be seen to coincide with the rib notches (not retouched).

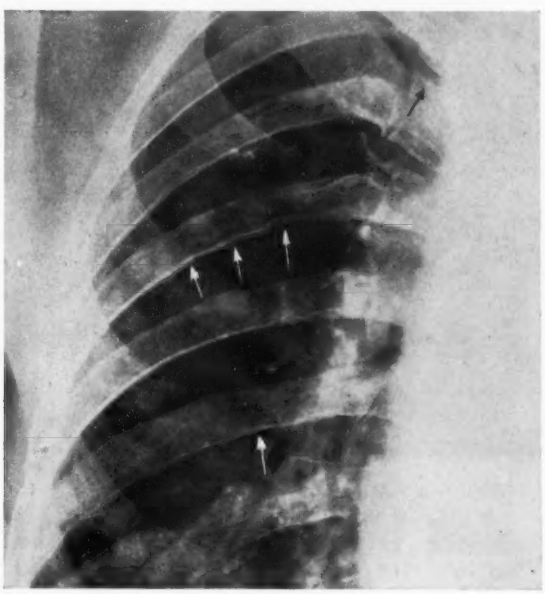

Fig. 2. Case 1. Chest roentgenogram, showing notching of ribs. The black arrow indicates the area of mediastinal calcification. The round densities are metastatic nodules.

Case II. A colored male, aged fifty-six, was admitted on December 8, 1949. For many years he had been aware of a visibly prominent pulsating mass on the right lateral chest wall. This was discovered in 1930 when he suffered an episode of bilateral shoulder pain while employed as an operator of a pneumatic hammer.

In 1945 he was found to have taboparesis

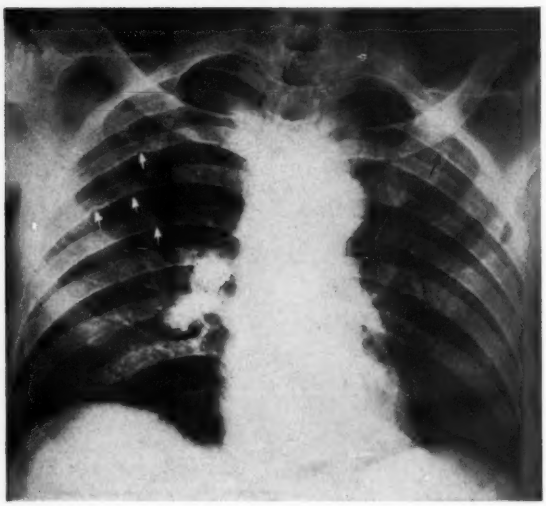

FIG. 4. Case II. Chest roentgenogram, showing rib notching (arrows).

and this condition had progressed in spite of therapy until he was completely disabled by blindness and ataxia. In October, 1949, he was hospitalized for an acute abdominal crisis which responded to conservative treatment. At that time rib notching was noted on a roentgenogram of the chest.

Physical examination revealed the classical findings of taboparesis. A number of tortuous arteries averaging 5 mm. in diameter were palpable subcutaneously in the right lateral chest wall, extending from a level high in the axilla to the seventh intercostal space. These arteries invariably collapsed with pressure either at a more cephalad point on the vessel or with compression of the right subclavian artery. No venous element could be observed. Blood pressure was 126/80 in both brachial arteries and 142/100 in both distal femoral arteries. All peripheral arteries showed normal pulsation. The heart, lungs, and abdomen were normal. There was no clinical suggestion of a coarctation of the aorta.

Laboratory findings were negative, except for positive serologic tests for syphilis. Roentgenograms of the chest revealed a normal cardiac silhouette and normal lung fields. There was rib notching of the posterior inferior borders of the right third to sixth ribs, inclusive. A questionable notch was also present in the left third rib (Fig. 4).

As the nature of the arterial abnormality was obscure, arteriography was performed. Under local anesthesia a polyethylene catheter was passed through the exposed right common carotid artery into the innominate artery and from there into the aorta. Roentgenograms were made following the injection of 70 per cent diodrast. These revealed a normal aortic arch and proximal descending aorta. There was no suggestion of coarctation. No intercostal arterial circulation was visualized.

The catheter was withdrawn into the innominate artery and the procedure was repeated. Roentgenograms revealed normal innominate, subclavian, axillary, and brachial arteries. The subscapularis was almost as large as the peripheral portion of the axillary artery. The thoracodorsal branch of the subscapularis was appreciably dilated and tortuous and showed numerous varicosities as it subdivided to anastomose with the intercostal arteries. The internal mammary artery was also well visualized and could be seen anastomosing with the

FIG. 5. Case II. Arteriogram, demonstrating the following arteries: (A) Innominate artery, (B) subclavian artery, (C) axillary, (D) subscapular, (E) long thoracic anastomosing with the intercostals, (F) brachial, (G) internal mammary artery, and (H) anastomotic vessels from the internal mammary to the intercostal. The curved linear streaks over the lower right chest are artefacts.

anterior portion of the fifth intercostal artery (Fig. 5).

SUMMARY AND CONCLUSIONS

When notching of the ribs is present on a roentgenogram of the chest, the underlying cause is usually found to be coarctation of the aorta. However, in rare instances rib notching is found associated with the tetralogy of Fallot and it has also been reported in cases of aortic valvular disease with and without hypertension. In several instances rib notching has been present without any apparent cause.

The present report deals with two cases of notching of the ribs without aortic coarctation. In one of these the notching was caused by dilated tortuous intercostal veins, the result of collateral circulation from a long-standing obstruction of the superior vena cava. This case is unique in that it is the first reported example of rib notching caused by venous dilatation.

In the second case the cause of the notching was not definitely ascertained, but arteriography revealed a marked collateral circulation adjacent to the rib lesion.

Notching of the ribs can no longer be considered a pathognomonic sign of aortic coarctation or even of dilatation of the intercostal arteries. Perhaps if angiography were performed on other cases of rib notching in which clear-cut evidence of aortic coarctation is lacking, more such cases would come to light.

The authors wish to express their appreciation to Dr. Benjamin Felson for valuable advice and suggestions concerning the preparation of this manuscript, and to Dr. James A. Helmsworth for performing the arterial catheterization on the second case.

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THE LAYERING PHENOMENON OF RENAL CALCULI

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IT IS the purpose of this paper to discuss and illustrate the phenomenon of layering of renal calculi.

While layering of renal calculi is rarely demonstrated, because of the absence of one or more of the necessary conditions, layering of gallbladder calculi is much more commonly seen. The roentgen technique for the demonstration of gallbladder calculi was popularized by Ettinger in 1936, who credited Åkerlund, Eliasz, and Bernstein with the historical priority. She emphasized the need for the added factor of compression as an essential feature, especially for the demonstration of the smaller or less dense calculi. Kirklin in 1948 added the advantage of the layering effect of gallstones to the right lateral recumbent posture. This posture also minimizes obscuration from the regional viscera, such as the colon.

PATHOLOGICAL ASSOCIATION

In order for calculi to layer they must be intimately associated with a fluid medium of a different specific gravity in a relatively closed space. Within the kidney one can find such conditions only within a cyst when outside the collecting system, or within a hydronephrosis (or its variants) when inside the collecting system.

ROENTGEN TECHNIQUE

In order to demonstrate the phenomenon of layering, three conditions are necessary:

1. Proper roentgen-ray beam direction: The roentgen rays must be parallel to the horizon in order to be at right angles to the pull of gravity.

2. Proper view of the proper roentgen-ray projection as related to the patient: Either sagittal views (anteroposterior or posteroanterior), the anterior oblique or either translateral projection are the best.

3. Proper posture of the patient: The upright posture is the easiest obtainable, although the layering phenomenon may also be demonstrated in the supine, prone and the lateral recumbent postures.

Four illustrative cases are presented.

Case 1. A male, aged forty-three, was admitted to the hospital complaining of increasingly severe upper abdominal pain for a period of about seven years. The pain became constant and localized to the epigastrium beginning two weeks before admission. In the past the pain was relieved by milk or milk of magnesia.

Physical examination was normal except for a questionable tender mass in the right upper quadrant.

Laboratory examinations were not revealing.

Simple roentgenogram of the abdomen revealed a cluster of calculi in the posterior portion of the right upper quadrant. This cluster bore a constant relationship to the right kidney.

Cholecystographic examination was normal. The upright posture film of the gallbladder series exposed in the left anterior oblique projection, utilizing a horizontal roentgen-ray beam, demonstrated that the renal cluster of calculi were exhibiting a layering phenomenon.

The patient was operated upon and the calculi were found within a cyst in the upper pole of the right kidney. The cyst measured 5 cm. in diameter.

Case 11. A white female, aged twenty-three, was admitted as an emergency with severe epigastric pain.

Simple roentgenograms of the abdomen exposed in the anteroposterior and posteroanterior projections, utilizing the supine and upright postures (with the roentgen beam directed parallel to the horizon in the latter), revealed multiple staghorn renal calculi. The smaller calculi exhibited the layering phenomenon at various levels. All the calculi maintained their relative positions within the confines of the kidney (except for postural changes), but varied in their relationship to the liver.

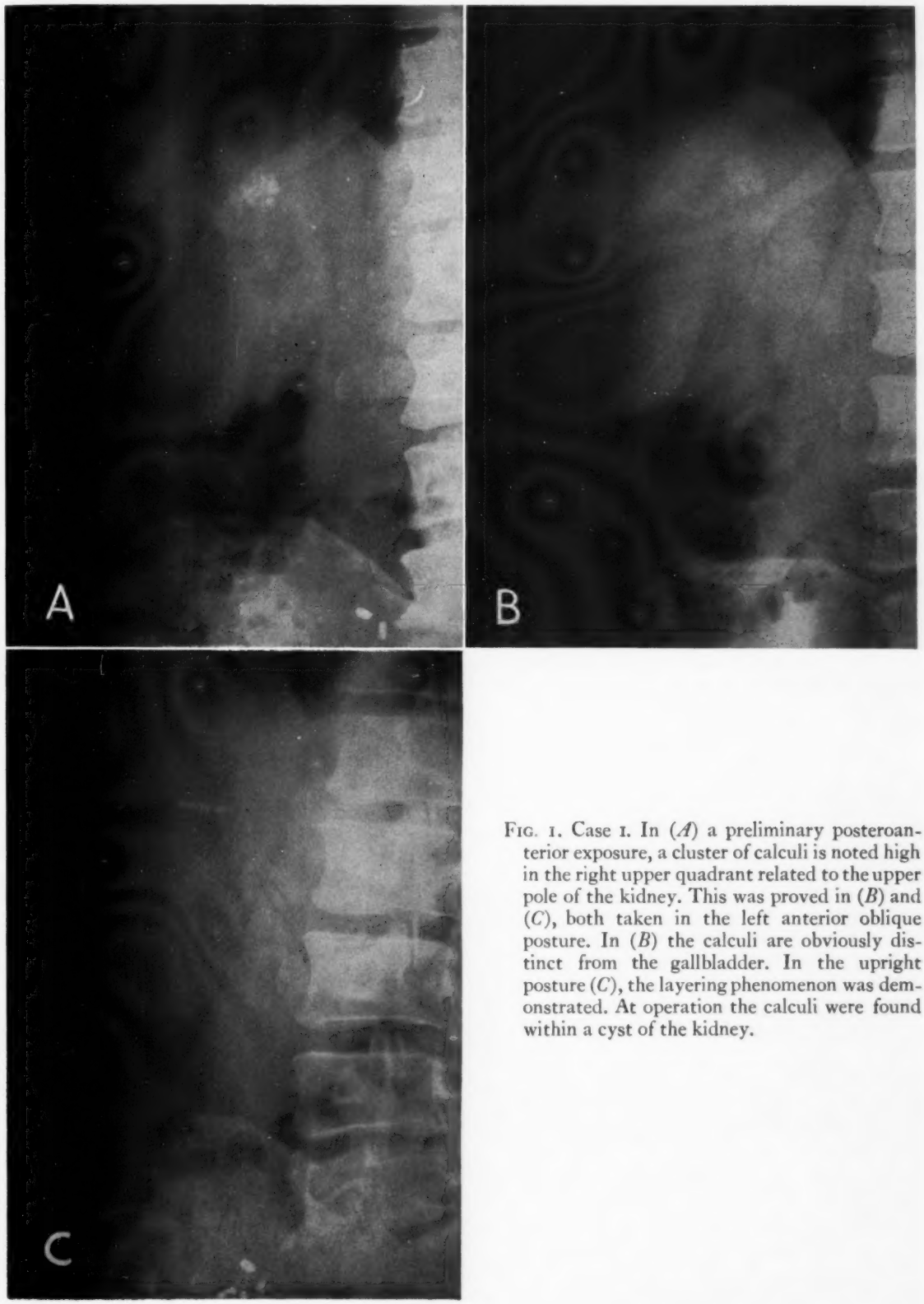
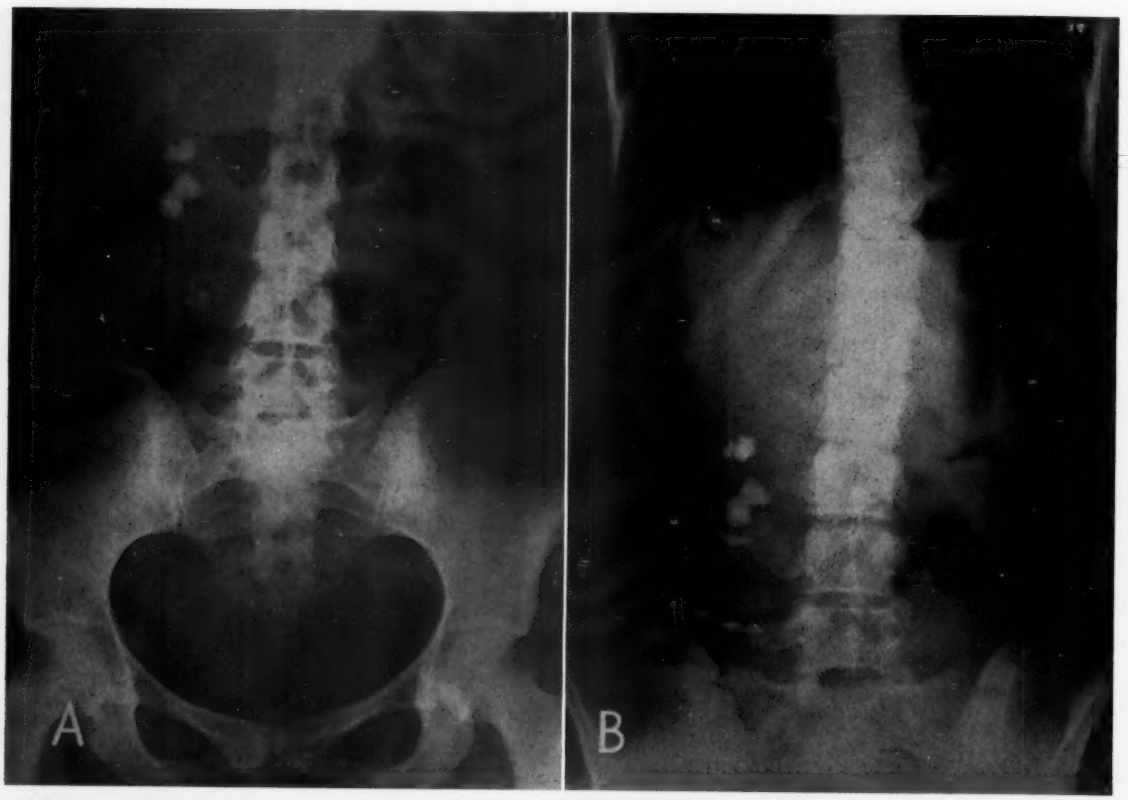


Fig. 1. Case 1. In (*A*) a preliminary posteroanterior exposure, a cluster of calculi is noted high in the right upper quadrant related to the upper pole of the kidney. This was proved in (*B*) and (*C*), both taken in the left anterior oblique posture. In (*B*) the calculi are obviously distinct from the gallbladder. In the upright posture (*C*), the layering phenomenon was demonstrated. At operation the calculi were found within a cyst of the kidney.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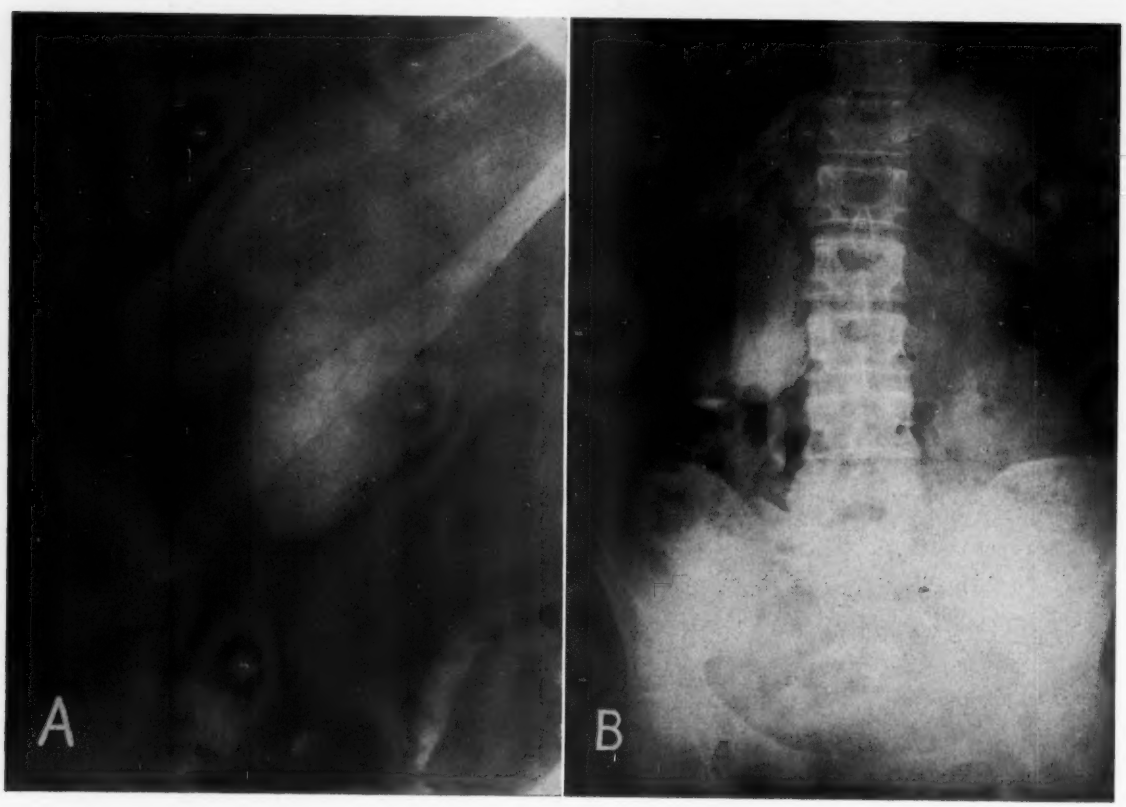
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Fig. 2. Case II. The roentgenograms, anteroposterior supine and posteroanterior upright, reveal multiple calculi with layering of the smaller peripheral calculi, proved by intravenous urography to be located in hydronephrotic calyces. Although in (*A*) some of the calculi appear beyond the kidney contour, they maintain their relationship with the kidney in the upright posture (*B*) and vary with reference to the liver, thus enabling a diagnosis of renal calculi with layering to be made prior to urographic studies.

Fig. 4. Case IV. (*A*) Preliminary film, (*B*) upright exposure thirty minutes after intravenous injection of dye. The layering phenomenon of the small renal calculi in the inferior pole of a kidney also containing large staghorn calculi is demonstrated.

Intravenous urography confirmed the diagnosis of renal calculi within a hydronephrosis exhibiting the phenomenon of layering when the three necessary conditions were fulfilled.

The patient refused operation.

Case III. A white female, aged fifty-six, consulted her physician for right upper quadrant pain, nausea and occasional vomiting.

Physical examination was normal.

Cholecystographic examination was normal.

Fig. 3. Case III. Routine film (*A*) during cholecystography showed a normal gallbladder. There is a faint smudge at the lower pole of the kidney, resembling feces. In the upright posture (*B*) the layering phenomenon made the calculi more distinct. They maintained their relationship with the lower pole of the kidney in the posteroanterior and the left anterior oblique, both in the upright posture. (The oblique film was not included.) There is also a large upper ureteral calculus. These findings were confirmed at operation.

There was a smudge-like density over the lower pole of the right kidney which in the upright posture and with the aid of the other necessary conditions was revealed as the layering of fine, gravel-like calculi. There was also a large upper ureteral calculus. Retrograde pyelography was unsuccessful in further elucidating the character of the calculi, since no dye passed beyond the large ureteral calculus. At operation, however, fine gravel-like calculi were found at the lower pole of a pyonephrotic kidney.

CASE IV. This case illustrates the phenomenon of layering of small renal calculi in the inferior calyx during intravenous pyelography in a patient with a calculi hydronephrosis when all the three necessary conditions were fulfilled.

CONCLUSION

The layering phenomenon of calculi, usually observed in the gallbladder under suitable conditions, may also be demonstrated in the kidney if the proper conditions prevail. The necessary conditions have been described.

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Vol. 67, No. 3

UNCOMMON COMPRESSING LESIONS OF THE SPINAL CORD AND ITS MEMBRANES*

WITH REPORT OF FIVE CASES

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OPAQUE myelography is an exacting procedure of invaluable aid to the neurologist and neurosurgeon. Like any other diagnostic procedure, it must be correlated with the clinical findings or otherwise prove misleading.

The value of myelography in establishing the diagnoses of discogenic disease and tumefaction of the spinal cord is generally accepted and recognized. The greater number of myelographic examinations made in a large general hospital are to confirm or rule out suspected intervertebral disc rupture with herniation, particularly in patients with atypical physical signs.

Several patients with uncommon obstructive lesions of the spinal cord were examined in the roentgen department of our hospital during the past two years. The purpose of this report is to emphasize the roentgen features of these rarer lesions, particularly those which present a characteristic appearance. The paucity of the reports in the literature describing the roentgen appearance of this group of lesions belies their importance. The roentgen features, no matter how bizarre, which identify a particular lesion should be familiar to the radiologist so that he may correctly interpret the findings in the light of the clinical picture as due to a pathologic process or faulty technique.

The 5 cases and illustrations which follow demonstrate the important role opaque myelography plays in establishing an earlier diagnosis, preventing further cord damage, and the aid rendered the surgeon in properly placing the level of the laminectomy.

Our procedure is the standard one used with patients suspected of having intervertebral disc herniation. Three to 6 cubic centimeters of pantopaque are inserted into the spinal subarachnoid space at a level usually lower than that of the suspected lesion. If the spinal fluid is aspirated freely, the pantopaque is injected steadily and slowly. The lumbar thecal space and the sacral cul-de-sac are first studied. If a defect is observed, an attempt is made to run the iodized oil to the area of suspected pathology from both directions and spot roentgenograms made for purpose of study and record. Actual roentgenoscopic observation is important for proper interpretation. Oblique and lateral roentgenograms are taken to supplement routine anteroposterior views as indicated. The opaque material is withdrawn under roentgenoscopic guidance only after the films have been studied and found adequate.

REPORT OF CASES

CASE 1. J. B., a white male, aged twenty-six, was admitted to the hospital on April 16, 1948, with a past history of a Brown-Séquard lesion on the right at T11 dating back to January, 1946. The night before admission to this hospital, during sexual intercourse, he suddenly experienced severe shocklike burning pain in the midback radiating down over the buttocks and into the anterior lower abdomen, both thighs and knees. Paralysis of the lower extremities followed, associated with incontinence of urine.

* Sponsored by the Veterans Administration and published with the approval of the Chief Medical Director. The statements and conclusions published by the authors are a result of their own study and do not necessarily reflect the opinion or policy of the Veterans Administration.

† Deceased.

Fig 1. Case 1. Arterial varicosities with compression of the spinal cord at T9-T10 vertebral level. Note the serpentine bands of diminished density within the pantopaque column characteristic of arteriovenous angioma.

The clinical impression was sudden spinal cord compression at T11 and T12 segments of the cord due to extrusion of nucleus pulposus, recurring intramedullary hemorrhage, or hemorrhage from extramedullary varix, angioma or arteriovenous aneurysm.

Myelography revealed snakelike defects beginning at T12 vertebral level with obstruction to the cephalad flow of the pantopaque at T9. The findings were typical of arteriovenous angioma (Fig. 1).

A laminectomy was performed of T9 to T12. A mass of tangled vessels having the appearance of arteries was found covering the entire exposed surface of the cord. The cord pulsated above and below, but not at these levels. Decompression was accomplished. The final diagnosis was arterial varicosities with compression of the spinal cord predominantly at T9–T10 vertebral level.

Comment. Arteriovenous angiomas are usually associated with dilated and tortuous arteries and veins. These enlarged vessels produce the characteristic serpentine radiolucent bands in the pantopaque column.

Two more intriguing cases of arteriovenous angioma of the spinal cord are not included in this report as the films, although diagnostic, are not of sufficiently good quality for reproduction. The roentgen pattern in all 3 cases is the same.

Angiomatous malformations of the spinal cord are less common than similar vascular malformations within the brain. These presumably congenital malformations are not to be regarded as true tumors. They may, however, cause irritation or pressure symptoms similar to actual neoplasms. These so-called "varices of the cord" represent true angiomatous malformations. The two types encountered are venous and arterial. Often both exist and it is not always possible to differentiate one from the other.

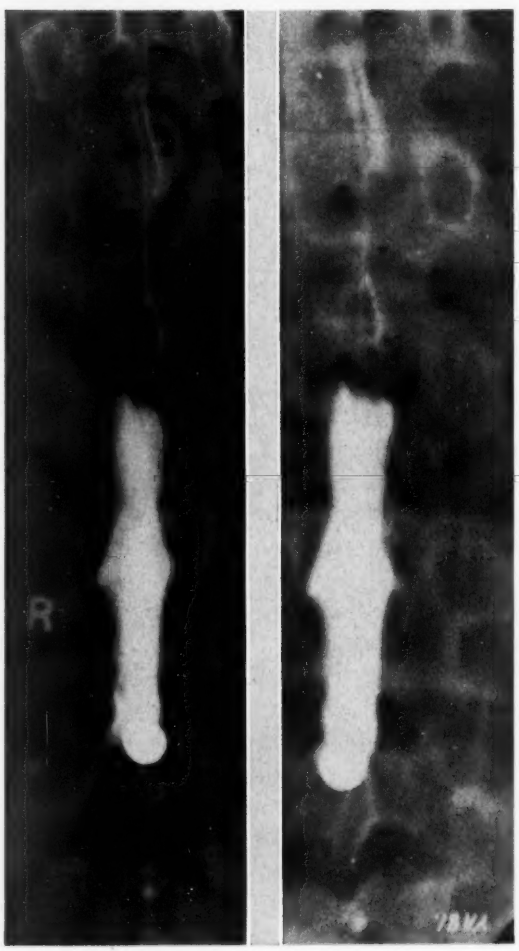

Fig. 2. Case 11. Herniated nucleus pulposus, midline, at L1–L2, with pantopaque block at level of transverse process of L3.

Case II. W. G., a white male, aged thirty-eight, was admitted to the hospital December, 1947, with a history of having lifted a heavy weight in the spring of 1945. Pain in the lumbar region of snapping quality followed immediately. There were frequent recurrences of severe backache with radiation of the pain into both legs.

Findings pointed to either an intraspinal cord tumor or herniated nucleus pulposus. There were no focal neurological signs implicating a specific nerve root or group of nerve roots. Manometric studies revealed a complete block to the circulation of the cerebrospinal fluid.

Myelography demonstrated a complete block to the cephalad flow of the pantopaque column at the level of the transverse process of the third lumbar segment. None of the opaque material could be made to pass the point of obstruction despite extreme tilt. The configuration of the defect suggested an extradural space-occupying compressing lesion (Fig. 2).

Laminectomy was carried out from the first through the third lumbar segment. The laminae of L2 and L3 were removed by merely picking them up with forceps. There was no evidence of neoplasm. The roots appeared moderately inflamed. A large midline protrusion of the disc was found between L1 and L2, approximately one and one-half vertebrae above the pantopaque block. The final diagnosis was herniated nucleus pulposus, L1–L2, midline.

Comment. Herniated nucleus pulposus at the L1-L2 lumbar interspace is extremely rare.

This case emphasizes the fact that the level of the block of the opaque medium produced by a midline herniated nucleus pulposus may occur at a relatively great distance from the actual site of the protruded disc. The factors accounting for the intervening space between the head of the column of the pantopaque and the level of the lesion are adhesions between the nerve roots and arachnoid, displacement of the dura and epidural fat, and engorgement of the epidural veins produced by the obstruction. This finding, if not correctly interpreted, may lead to a false level of localization and an inaccurate specific diagnosis. The discrepancy in the level of the pantopaque block has been observed in 2 patients subsequently examined with midline protrusions of the intervertebral disc substance.

Case III. L. DeL., a white male, aged twenty-six, with congenital lues and interstitial keratitis, recovering from a recent bout of jaundice, was admitted to the hospital in September, 1947, complaining of low back pain, urinary retention and progressive weakness of the lower extremities.

Examination showed hyperreflexia of the arms, hyporeflexia and marked weakness of the lower extremities. A spinal tap revealed a complete block with xanthochromic fluid which contained numerous white blood cells, chiefly lymphocytes.

The diagnoses entertained were cord compression at the level of T8–T11 secondary to cord tumor or epidural abscess, myeloradiculitis of virus etiology, infectious myelitis, transverse myelitis, or venous thrombosis of the spinal cord vessels.

Myelography showed a complete obstruction to the passage of the opaque material in the cephalad direction at the vertebral level of

Fig. 3. Case III. Infectious myelitis with edema of cord resulting in pantopaque block resembling intramedullary tumor. Note the crescentic appearance of the head of the column.

FIG. 4. Case IV. Adhesive arachnoiditis demonstrating characteristic irregular channeling and pocketing of pantopaque column.

T11. The crescentic configuration of the head of the pantopaque column suggested an intramedullary tumor mass or edema of the cord (Fig. 3).

Laminectomy of T10, 11 and 12 was performed. The cord was found markedly injected, swollen, firm and pulseless. The final diagnosis was infectious myelitis with edema of the cord.

Comment. In the majority of cases, the myelographic examination enables the physician to differentiate neoplasms, inflammatory diseases, posttraumatic processes, anomalies of the circulatory system, and degenerative disorders. Gliomas of the spinal cord usually distend the cord and its membranes, resulting in complete obstruction to the flow of the pantopaque. This case is one which could easily be interpreted as representing an intramedullary space-occupying tumor and stresses the importance of correlation of the myelographic findings with the clinical picture.

CASE IV. C. T., a white male, aged twenty-seven, suffered a cerebral concussion in March, 1945, when a shell exploded in his immediate vicinity. Seven months later, while on furlough, he developed sudden dizziness, faintness and pain and weakness in the right lower extremity. Spinal tap showed bloody fluid. Subsequently, he developed weakness of both legs and flexor spasms. In July, 1946, he was no longer able to walk. The patient had a positive Wassermann reaction in 1937 and was treated with intramuscular and intravenous injections at weekly intervals for one and one-half years. He presented almost a complete spastic paraplegia upon admission to the hospital with the clinical diagnosis of hematomyelia.

Myelography revealed obstruction to the cephalad flow of the pantopaque at the level of L1–L2. The opaque medium appeared irregularly channeled and pocketed over several of the lumbar vertebral segments. The pattern was typical of adhesive arachnoiditis (Fig. 4).

Laminectomy of T12, L1, 2 and 3 was performed. The arachnoid membrane appeared milky white and numerous adhesions extended to the cord and dura. Thick adhesive bands encircled the cord at the level of T12. The final diagnosis was adhesive arachnoiditis.

CASE V. J. L., a colored male, aged twenty-eight, was admitted to the hospital in March, 1948, with a transfer diagnosis of syringomyelia and a recommendation that he receive roentgen therapy. There was a five year history of progressive spastic paraparesis, and impairment of temperature perception of the left hand, arm and leg. Patient had both syphilis and meningitis in 1937.

There was a bilateral spastic paraparesis without any involvement of the cranial nerves or evidence of focal muscle atrophy. There was diminution of pain and temperature sensation on the left side in the segments of the 2nd, 3rd and 4th cervical dermatomes, and an area of loss of pain and temperature sensation from the 4th cervical to the 8th thoracic segments. Gold curve was abnormal and of the luetic type.

Myelography was initially done by the lumbar route and showed splitting of the column in the lower thoracic region with

complete arrest of the opaque at the level of T7. To determine the extent of the block, pantopaque was injected by the cisternal route. The column broke up at about T2, appeared irregularly interrupted caudally, and completely blocked at the level of T6. A very minimal amount of the opaque trickled down to the level of T9. The roentgenograms were typical of adhesive arachnoiditis (Fig. 5), and similar to Case IV.

Laminectomy of T1, 2 and 3 was performed. The dura was thickened and the subarachnoid space obliterated by thick adhesions. A fine catheter passed cephalad and met an obstruction at 6 cm. A block was also met in passage of the catheter in the caudad direction. The final diagnosis was extensive adhesive arachnoiditis, cervical and thoracic areas.

Comment. In view of the history of meningitis and lues and positive gold curve, postmeningeal adhesive processes with luetic vascular disturbance of the spinal cord were considered. Syringomyelia was not excluded but was thought to be associated, if present, with these other changes. The clinical evidence pointed to intramedullary disease of the spinal cord, chiefly on the right side in the cervical region. A degenerative type of disease on the basis of postmeningeal adhesions and arteritis seemed most likely.

This case is illustrative of the definite value of myelography in helping to establish a preoperative diagnosis and the invaluable assistance to the surgeon in localizing the extent of the pathologic process. Both Cases IV and V demonstrate the pathognomonic roentgen appearance of adhesive arachnoiditis with complete block at the involved segments and irregular channeling and trapping of the pantopaque and irregular radiolucencies between the channels. Although the etiology of the adhesive arachnoiditis in Case IV is entirely different from that of Case V, the roentgen pattern of the scattered opaque medium is the same.

Fig. 5. Case V. Extensive adhesive arachnoiditis with pathognomonic roentgenographic appearance as indicated in Figure 4.

CONCLUSION

(1) Five uncommon compressing lesions of the spinal cord and its membranes with several demonstrating pathognomonic roentgen features in the myelogram are presented.

(2) The important role of opaque myelography in establishing the level and early identification of this group of unusual lesions is emphasized.

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CANCER OF THE GUMS*

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TO THOSE who are not familiar with intraoral cancer, a paper devoted to carcinoma of the gingivae, which is generally considered to be a rare disease, may appear to have little justification. It is true that lesions limited entirely to the gums are rare, but a study of 218 consecutive cases of cancer of the mouth treated three or more years ago in our clinic revealed such lesions, usually produced as secondary extensions, in 87 cases (40 per cent). In Texas where tobacco chewing and snuff dipping are still common practices among the older generation the problem is an important one.

It is not our intention to review the various surgical techniques described by Blair, Brown and Byars,[2] Johnson and Daniel,[7] Hayes Martin,[12] and others, nor the roentgen-ray, contact radium and radon techniques of such authorities as Richards,[15] Pfahler,[14] Cutler,[6] Martin and Pflueger,[11] and others. Rather, we wish to discuss the controversial subject of interstitial therapy and to emphasize the advantages of low intensity radium needles in the treatment of cancer of the gums. This is done with the full knowledge that the interstitial method has been condemned by many. Ackerman and del Regato[1] state that "interstitial Curie therapy should not be considered in the treatment of these tumors because in addition to the usual disadvantage of such a procedure there may also be bone necrosis and sequestration." It is the opinion of Cutler and Buschke[5] that "interstitial irradiation is contraindicated because of the close proximity of bone and the imminent danger of osteoradionecrosis." Even Cade,[4] who has advocated the intraoral use of low intensity radium needles for many years, says, "it is the fear of necrosis and the necessity of giving big doses that renders this situation entirely unsuitable for interstitial irradiation." Because of the high incidence of radiation necrosis observed in their cases, Ward and Hendrick[16] routinely remove the treated area in four to six weeks after the radiation therapy is given.

TECHNIQUE

The low intensity radium needles used in our clinic are quite similar to those recommended by Cade[3] and Paterson[13] and have been described in detail in previous articles.[8,9] They produce a constant output of low intensity gamma rays and are stitched in place for a period of seven days. The technique includes no variable factors except the implantation patterns which are arranged so that all of the malignant tissue receives doses varying from 6,000 to 12,000 gamma roentgens. The establishment of an efficient pattern in a lesion growing from the gum is often quite difficult and each case is a problem in itself. For the most part the needles are inserted into or beneath tumor tissue but the retaining stitches must pass through normal mucous membrane if they are to serve their purpose. The work must be done with great gentleness and even then it is often necessary to replace one or more needles that have slipped out of position before the treatment is finished. All of the work is done after the induction of local anesthesia and the needling of the gum about small tumors is often made easier by the production of a moderate edema of the normal

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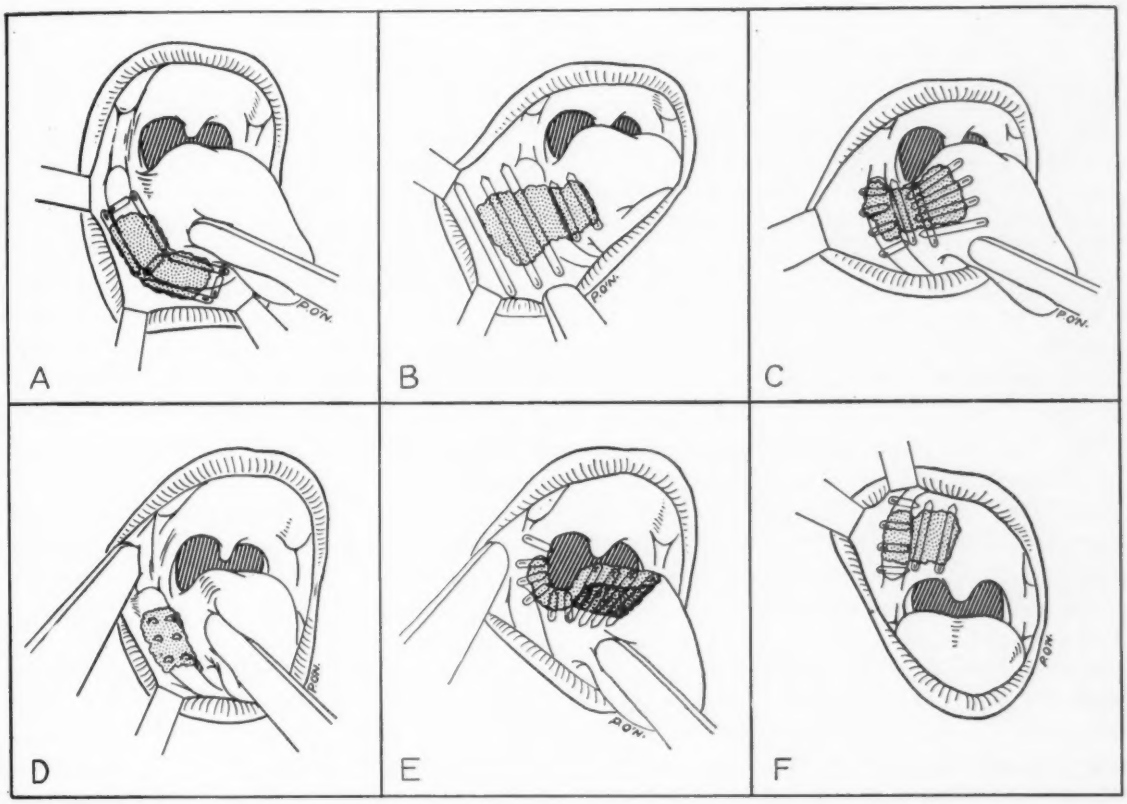

Fig. 1. Some of the needle patterns used for cancers of the gums and adjoining structures designed to deliver doses varying from 6,000 to 12,000 gamma roentgens in a period of seven days.

mucosa with the injected solution. The distribution of the radioactive sources must insure the delivery of proper dosage to the portions of the tumor which invade the surrounding structures such as the cheek, floor of the mouth, tongue, anterior pillar, palate, etc. Some of the patterns which have been used successfully are illustrated in Figure 1. When lymph node metastases are present they are treated by the combined low intensity radium needle and roentgen-ray technique recommended in a previous article.[10] Surgery, when it is used at all, is resorted to as a secondary procedure for the removal of irradiation necroses or patches of uncontrolled cancer.

CLINICAL MATERIAL

A study of the group of intraoral carcinomas treated from 1931 to 1947 revealed that the gums were involved in 87 cases. The disease was limited to the gums in only 13 cases. The extent of the lesions found in the other patients is indicated in Table 1 and, as one would suspect, the cheek and floor of the mouth were the most frequent sites of involvement outside the gingivae. Material was obtained for biopsy studies in all but two patients both of whom had advanced lesions which eventually caused their death. All of the lesions were relatively low grade squamous cell carcinomas except one basal cell tumor which had ex-

Table I

REGIONS INVOLVED IN 87 PATIENTS WITH CANCER OF THE GUMS

Region	Cases	Region	Cases
Gum and alveolus	13	Anterior pillar	5
Cheek	51	Lip	2
Floor of mouth	19	Antrum	2
Hard palate	5	Tonsil	1
Tongue	5	Nasal passage	1

TABLE II

CANCER OF GUMS AND ADJOINING STRUCTURES TREATED WITH RADIUM NEEDLES

Time Followed	Total No. Patients	Patients Well
3 yr. or more	87	38 (43.6%)
5 yr. or more	70	28 (40.0%)

tended through the lower lip to invade the lower jaw and overlying gums.

The average age of the patients was sixty-four, but 35.6 per cent were seventy or more years of age. In 22 cases (25 per cent) the bone underlying the neoplasm showed definite malignant invasion at the time of admission. In 21 (24 per cent) cervical lymph nodes were palpable at the time of admission, and in 12 (13.7 per cent) they became apparent at a later date. In other words, the incidence of metastatic nodes amounted to 33, or 37.9 per cent of the total of 87 cases.

RESULTS

The results obtained in 87 consecutive unselected cases is shown in Table II. Very few properly tabulated five year cure rates can be found in the literature. Hayes Martin reports 25.7 per cent of 105 determinate cases well for five years. It seems probable that our higher cure rate (40 per cent) was obtained because of a more favorable material at the time of admission. Of the 38 patients who remained well for three or more years, the primary lesion was 2.0 cm. or more in diameter at the time of admission in 75 per cent and 3.0 cm. or more in diameter in 33 per cent.

Since interstitial therapy has been so generally condemned we wish to stress the fact that complete healing of the primary lesion occurred in 63, or 72.4 per cent, of 87 cases. It is also worthy of note that irradiation necrosis of bone was observed in only 12 cases (13.7 per cent) and that 8 of these have remained well for five or more years.

TABLE III

PATIENTS REQUIRING SURGERY FOR IRRADIATION DAMAGE

	Malignant Lesion	Previous Treatment	Treatment in our Clinic		Treatment of Complications	Results
			Radium needles	Roentgen rays		
W.A.C.	Gum and cheek	None	Patterns inside and outside	6×350 r to cheek and neck	Resection of slough and mandible	Well 12 yr., 7 mo.
Mrs. L.M.	Gum and cheek	None	Patterns inside and submental	6×350 r to cheek and neck	Resection slough and mandible	Died 3½ yr., pneumonia
Mrs. B.W.	Gum and cheek; submaxillary node	None	Patterns inside and submaxillary; repeat	6×350 r to neck, repeated	Resection slough and mandible	Died 3 yr. 7 mo.
J.M.M.	Gum, palate and cheek	12 roentgen treatments elsewhere	Pattern inside	None	Resection floor of antrum	Well 6 yr. 9 mo.
M.B.G.	Gum and cheek; submaxillary hard node	22 roentgen treatments elsewhere	Patterns inside and submaxillary	6×350 r to neck	Resection of denuded mandible	Died 1 yr. 1 mo.
Mrs. C.G.	Gum and hard palate	None	Pattern repeated at 6 mo.	None	Resection of alveolus and palate	Died 1 yr. 2 mo.
C.E.S.	Gum and floor of mouth	None	Improper pattern	None	Resection slough floor of mouth	Well 5 yr. 2 mo.
M.M.	Multiple gum, cheek, floor of mouth, submaxillary node	None	Patterns repeated. Overlapping inside and outside patterns	6×350 r to neck	Resection slough and mandible	Well 4 yr.

TABLE IV

PATIENTS WITH MALIGNANT BONE INVASION RESPONDING TO RADIATION THERAPY

	Malignant Lesion	Bone Involved	Primary Result	End Result
T.P.	Lower gum and cheek	Alveolar margin	Complete healing	Recurred at 4 yr. 10 mo.
W.A.D.	Lower gum and cheek	Alveolar margin	Complete healing	Recurred at 6 yr. 8 mo.
J.H.	Lower gum and lip	Upper half of ramus	Healing with separation of jaw	Well 16 yr. 8 mo.
F.R.	Upper gum	Alveolar margin	Complete healing	Well 13 yr.
J.S.	Lower gum and floor of mouth	Alevolar margin	Slow healing	Well 8 yr.
W.D.	Gum and floor of mouth, submaxillary node	Upper half of ramus	Slow healing with separation of jaw	Well 3 yr. 5 mo.
T.S.S.	Upper gum, submaxillary node	Alveolar margin	Complete healing	Well 5 yr. 7 mo.

It was found necessary to carry out surgical procedures for the removal of bone and soft tissue severely damaged by irradiation in 8 cases (Table III). A careful study of the techniques used is very informative since we now believe that the irradiation damage might have been prevented in each instance. The causes of the serious reactions may be listed as follows: (1) the simultaneous use of radium needle patterns placed inside and outside the cheek in close proximity to one another; (2) the simultaneous use of needle patterns in the mouth and submaxillary regions with heavy roentgen therapy administered to both areas at the same time; (3) the implantation of radium needles in the mouth soon after the use of intensive external roentgen therapy in another clinic; (4) the use of an improper pattern with the needles placed too close together; and (5) the repetition of a radium needle implantation in the same area within a period of six months.

Since almost all authorities are agreed

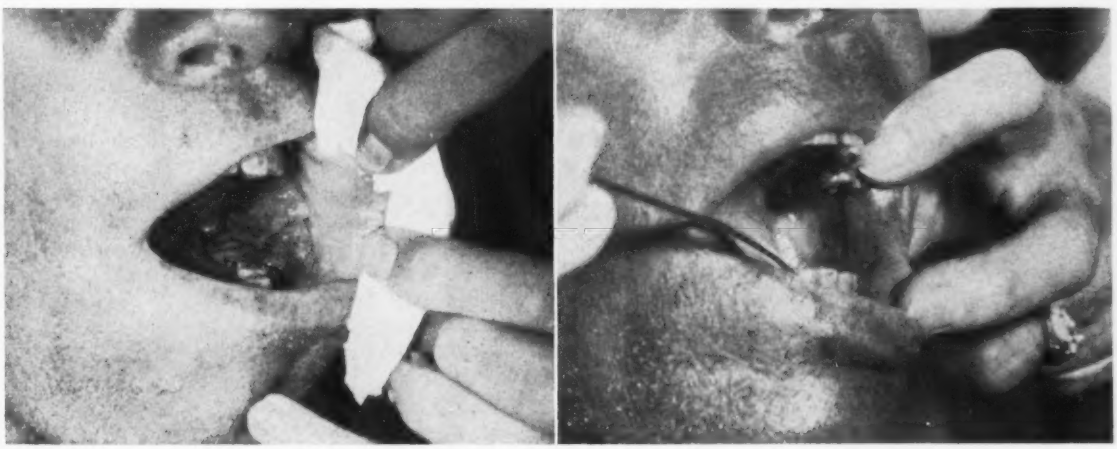

FIG. 2. Squamous cell carcinoma, Grade 2, measuring 4.0 cm. in diameter which involved the lower left gum and adjoining cheek. The treatment was carried out with low intensity radium needles and the patient was well six years later when the photograph on the right was made.

FIG. 3. Cauliflower squamous cell carcinoma of lower right gum measuring 3.0 cm. in diameter. Treatment consisted of the implantation of four 1.33 mg. radium needles longitudinally and two 0.66 mg. needles transversely for seven days. Complete healing at the end of a year is shown on the right.

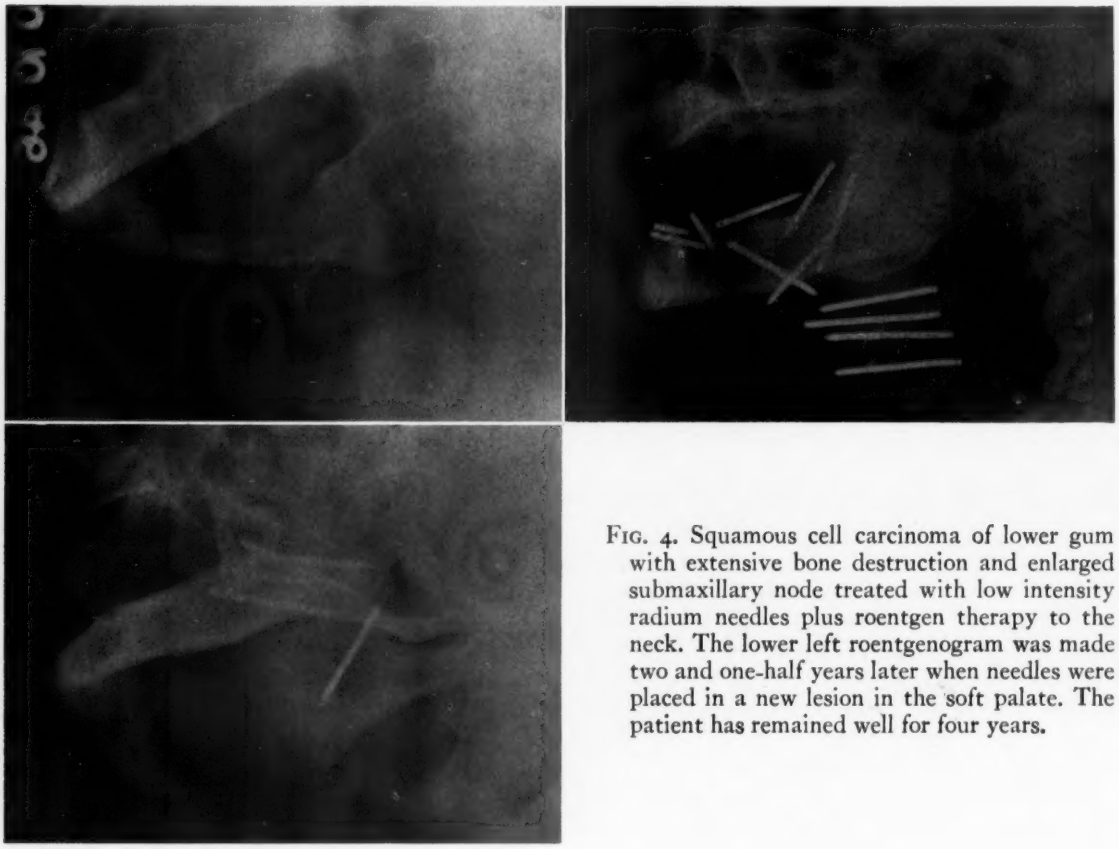

FIG. 4. Squamous cell carcinoma of lower gum with extensive bone destruction and enlarged submaxillary node treated with low intensity radium needles plus roentgen therapy to the neck. The lower left roentgenogram was made two and one-half years later when needles were placed in a new lesion in the soft palate. The patient has remained well for four years.

Fig. 5. Squamous cell carcinoma 9.0 cm. in diameter involving the entire lower left alveolus with extensive destruction of the mandible and invasion of the cheek. Two large submental nodes were palpable. The illustrations on the right were made six months after a low intensity radium needle implantation plus roentgen therapy to the neck when no evidence of carcinoma could be made out.

that squamous cell carcinoma growing in bone cannot be treated successfully with irradiation, the results tabulated in Table IV are of unusual interest. In each case the alveolar process underlying a primary lesion showed definite destruction. Good results were not obtained in all of the patients having bone involvement but the 7 listed in Table IV obtained complete healing of the gums and were free of discomfort. No new bone ever appeared in the defects and complete separation occurred in the two mandibles showing extensive invasion. It is true that recurrences were observed after long periods in 2 cases but the evidence presented is sufficient to indicate that direct extension of cancer of the gingiva into the alveolar process does not necessarily contraindicate radiation therapy. It is now our practice to use a low intensity radium needle implantation as the first procedure, reserving radical surgery for those patients who do not show rapid improvement.

COMMENT

A comparison of our techniques with those advocated by the opponents of interstitial therapy is now in order. Contact radium therapy administered with bulky molds utilizes gamma rays and produces good results when the lesions are relatively small, limited to the gums and quite superficial. The method could have been used successfully in only 15 per cent of our cases. The preparation of a mold is a rather difficult time-consuming procedure, and its use at intervals over a period of several days necessitates constant supervision if proper dosage is to be attained.

Most American radiologists favor a combination of intraoral and external roentgen therapy of the type advocated by Hayes Martin. He administers 5,000 to 7,000 r with 200 to 250 kv. equipment, or 10,000 to 15,000 r with 100 to 120 kv. equipment to the primary lesion in twenty to twenty-five days. To this he adds 4,000 to 5,000 r through an external portal (3.5 to 5.0 cm. in diameter) given to the same area within a period of three weeks. Such a technique must of necessity deliver a very large dose to a relatively large segment of bone well beyond the malignant tumor. He reports radionecrosis of soft tissues in 50 per cent of his cases and more than half of this group eventually develop radio-osteomyelitis. It is our belief that cancerocidal doses of low voltage roentgen rays produce more damage to normal tissues than do similar doses of low intensity gamma rays. Even if this were not true, the volume of bone irradiated by a careful radium needle implantation is much smaller and consequently the undesirable damage is much less.

Another advantage of needles lies in the ease with which they can be placed so as to completely irradiate large lesions of irregular size and complex distribution. The entire treatment requires two procedures in most cases, the insertion and removal of the needles, whereas roentgen therapy necessitates a daily attempt to maintain a small cone in proper position in the open mouth for a period of many days. When large extensions beyond the gingivae are present, it may be impossible to insert an intraoral cone so as to properly irradiate the entire area.

Hayes Martin also implants radon seeds in areas showing residual carcinoma after roentgen therapy. Since these seeds as they are used in this country give off some beta radiation it is our opinion that they should never be used in contact with bone. Radium needles are stitched in position and attached to a guy thread so that they can be quickly replaced when they get out of position. Seeds placed in gum lesions can be displaced and may be swallowed or even aspirated. Our experience also indicates that the repetition of any type of irradiation in the same area is likely to produce necroses and should be avoided when possible.

We have had no experience with supervoltage roentgen therapy or radium bomb techniques but feel that their chief disadvantage consists of the large amount of nor-

mal tissue which must be irradiated unnecessarily when they are utilized.

CONCLUSION

1. A five year cure rate of 40 per cent was obtained in a series of eighty-seven cases of carcinoma of the gums and adjoining structures using implanted low intensity radium needles as the primary method of treatment.

2. Improvements in technique should eliminate most of the irradiation necroses requiring surgery.

3. In some cases malignant invasion of bone can be controlled with irradiation, thereby avoiding a jaw resection.

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RADIOCURABILITY OF CANCER*

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A CANCER may be regarded as radiocurable, if past experience with similar cancers makes it probable that freedom from clinical evidence of cancer, for at least five years, will result from treatment with roentgen rays, radium or radioactive substances. The term cure in connection with cancer is unfortunate as it expresses an opinion, which later may prove to have been wrong. The term radiocurability in the sense it is used here, *i.e.*, freedom from clinical evidence of cancer for at least five years, seems justified, as it pertains only to the fact that, during this period, evidence of cancer did not reappear clinically. The term is also of value as it permits comparison with surgical statistics in similar groups of cancer. Radiocurability of cancer and the technique of radiotherapy are influenced by the natural clinical course, location, extent and radiosensitivity of the untreated cancer, as well as the patient's tolerance of the required cancerocidal dose. Radiotherapy by means of radioactive isotopes, which will concentrate only in cancer cells, has as yet not been discovered. Correct placement of radiation, therefore, depends on accurate clinical localization of the cancer. The latter presupposes familiarity with regional anatomy, with the usual routes of extension and growth characteristics of the cancer and a correlation of history, physical and laboratory findings. The technique of radiotherapy is influenced by this anatomic information, by clinical judgment and a consideration of physical and biological principles of radiotherapy. Acquisition of this combined knowledge requires long personal observation in regional cancer clinics, in cancer conferences, at the operating and postmortem table, and follow-up of treated patients. The planning and administration of cancerocidal radiotherapy is time-consuming and should not be done in a hurry. The training and experience, as well as the personal care given the individual patient by the radiotherapist, have a direct bearing on the radiocurability of cancer.

RADIOCURABILITY AND NATURAL CLINICAL COURSE OF THE CANCER

An inherent tendency to slow growth in the untreated cancer will increase the proportion of five year survivors among treated patients. Thus, cohesively growing differentiated cancers, with well developed connective tissue stroma, are prone to grow slowly and be of limited extent when irradiated, irrespective of whether they are epitheliomas, mammary or other carcinomas. Less differentiated growths in the same group of malignant neoplasms, with little stroma to hold the cells together, are likely to progress more rapidly, spread more readily and be wider in extent when treated. For instance, among 91 patients with malignant nasopharyngeal growths irradiated at the Presbyterian Hospital, cervical lymph node metastases as the initial clinical symptom were noted in 40 per cent of undifferentiated epitheliomas, lymphosarcomas and lymphoepitheliomas, and in only 13 per cent of well differentiated epitheliomas and cylindromas.[21] This lesser tendency to spread increases the likelihood of radiocurability in differentiated cancers, providing the growth is small and accessible to adequate irradiation. In more extensive, less accessible tumors, undifferentiated neoplasms may be more radiocurable, because of their greater radiosensitivity. Even in extensive cases, however, the slower growth of differentiated tumors may result in longer survival. Thus, patients with skeletal metastases[14] receiving

* President's address delivered in part before the Thirtieth Annual Meeting of the American Radium Society, Chicago, Illinois, June 20–22, 1948.

roentgen therapy at Montefiore Hospital survived longer when the primary breast cancer showed some differentiation than when it was undifferentiated. The influence of differentiation on survival may also be seen in our experience with lymphosarcoma. The proportion of symptom-free patients five years after roentgen therapy among 242 patients with lymphosarcoma, irradiated at the Presbyterian Hospital, New York, increased from 12 per cent (of 130) to 23 per cent (of 67) to 41 per cent (of 43 patients), depending on whether the growth belonged to the group of reticulum, lymphocytic cell or the more differentiated giant follicle lymphosarcoma.[20] In several of the five year symptom-free survivors with giant follicle lymphosarcoma the disease had become generalized before irradiation.

Age and sex influence the natural clinical history of cancer. Survival has generally been short in children receiving roentgen therapy at the Presbyterian and Montefiore Hospitals for Hodgkin's disease, lymphosarcoma, leukemia and various sarcomas. Cancer in the aged, on the other hand, has seemed to grow especially slowly. The relative proportion of five year survivors has been higher in our female, as compared to our male patients with Hodgkin's disease, lymphosarcoma, cancer of the larynx and some other cancers.

A patient with cancer which is still limited in extent, in spite of a long history, is likely to survive longer than one whose cancer is extensive, though noted only a short time.

Consideration of the natural clinical course of the untreated cancer should be included in evaluation of radiotherapy of cancer.

RADIOCURABILITY, LOCATION, EXTENT AND ACCESSIBILITY OF CANCER

The location, extent and accessibility of a cancer have a definite bearing on the accuracy of clinical localization, correct selection of radiation fields and thus on radiocurability of cancer.

Thus, epitheliomas located on the skin or on the mucosa of the upper respiratory or digestive tracts are likely to be discovered earlier than similar epitheliomas in the bronchi or mid-esophagus. A primary breast cancer and axillary metastasis may be recognized clinically, whereas involvement of the internal mammary nodes is rarely diagnosed preoperatively.[8]

Location, where symptoms are prominent and where the part is accessible to clinical examination, facilitates early diagnosis and increases the likelihood of treatment before the cancer has become extensive. For instance, cancer of the larynx producing hoarseness due to a growth on the edge of the vocal cord is likely to be diagnosed more promptly than cancer on the laryngeal band, which does not give early symptoms.

Papillary exuberant cauliflower epitheliomas growing outward are more apt to be traumatized, bleed and be diagnosed early, than ulcerating invasive types. The latter more than the former tend to infiltrate insidiously into deeper tissue layers, to spread locally and to metastasize. Because of the likelihood of silent extension, wider radiation fields are necessary for invasive rather than for exuberating types of cancer.

Cancer spreads principally along fascial planes, lymphatics, veins, serous surfaces, etc. The direction and extent of the growth is determined by the availability of these facilities and such tough barriers as fascia, dura or bone. For instance, subdural spread of nasopharyngeal cancer may lift up the dura but rarely penetrate it. It may extend into the carotid sheath and grow upward and downward within it, compressing the carotid artery; exceptionally it may penetrate the vessel, and only late in the disease may it grow outside of the sheath. The choice of radiation fields is influenced by this information. Thus, in radiotherapy of a Ewing's endothelioma which may appear to be limited to one end of a long bone, the entire bone and not only the clinically invaded part should be irradiated, because

of the likelihood of silent extensions along the haversian canals.

Paucity of lymphatics retards and a rich lymphatic network facilitates local spread and metastasis. The lymphatics on the free edge of the vocal cords are few and delicate; those in the pyriform sinus are coarse and abundant. Clinically metastatic nodes were present on admission to radiotherapy at the Presbyterian Hospital in 9 of 40 patients with laryngeal cancer starting on the vocal cords, and in all of the 26 patients whose cancers arose in the pyriform sinus.[18]

Estimates of the extent of cancer based on microscopic examination are more reliable than when they depend solely on clinical impression. Microscopic evidence of widespread invasion of regional drainage nodes, *e.g.*, axillary lymph nodes in mammary cancer, suggests extensive involvement and the likelihood of a short survival. The percentage of five year symptom-free survivors among 540 patients with mammary cancer treated by radical mastectomy, with or without postoperative roentgen therapy, at the Presbyterian Hospital, was 79 per cent (of 223), 50 per cent (of 190), 26.5 per cent (of 87) and 15 per cent (of 40 patients), depending on whether microscopic examination of axillary nodes showed them to be free of metastases, invaded in less than half of the nodes, involved in more than half, or metastases in all the nodes examined.[19]

Correct evaluation of radiotherapy in a particular group of cancers, is impossible without accurate information as to the extent of the involvement. For instance, a superficial comparison of the five year survival after radical mastectomy for mammary cancer among 324 patients treated only surgically and 270 patients receiving in addition postoperative roentgen therapy at the Presbyterian Hospital, New York, between 1930 and 1942,[19] gave the erroneous impression that post-mastectomy roentgen therapy lowered five year survival. This error was not corrected until the details of the extent of the cancer noted on microscopic examination in these two series of cases were compared. This showed that the cancer in patients exposed to postoperative roentgen therapy in each instance was more extensive than in the cases which were not irradiated; thus the two series were not comparable and the conclusion, that postoperative roentgen therapy did harm, was wrong.

Radiocurability is reduced with increasing extent of the cancer. This reduction occurs irrespective of inherent radiosensitivity of the growth. This rule holds true in squamous epithelioma of the skin, oral cavity, upper respiratory and digestive tracts and cervix uteri, requiring a relatively high cancerocidal dosage as well as in more radiosensitive malignant growths such as lymphosarcoma. Thus, the five year survival rate after roentgen therapy among 242 patients with lymphosarcoma irradiated at the Presbyterian Hospital, decreased from 54 per cent (of 37) to 25.7 per cent (of 70) to 9 per cent (of 135 patients), depending on whether the patient, on admission to radiotherapy, presented one, two or three clinically recognizable sites.[20]

RADIOCURABILITY AND RADIOSENSITIVITY OF THE CANCER

Radiocurability is affected by the inherent radiosensitivity of the cancer. The inherent radiosensitivity determines the tumor dose required for destruction of the growth. This is usually increased as one gains clinical experience with radiotherapy of individual groups of cancers. At the Presbyterian Hospital, improvement in radiocurability was noted with increase in tumor doses used for the treatment of cancers of the urinary bladder, larynx, breast and even in lymphosarcoma as follows:

1. Single cancers of the urinary bladder in 40 patients were treated by cystostomy and implantation of radium needles in cooperation with the staff of the Urological Service. The relationship between the number of gamma roentgens used and clinical freedom from cancer five years af-

ter this treatment varied as follows: Clinically arrested were 2 of 16 patients receiving tumor doses of less than 7,000 gamma roentgens, 2 of 8 patients receiving tumor doses of 7,000 to 8,000 gamma roentgens, and 5 of 16 patients receiving tumor doses somewhat above 8,000 gamma roentgens.[17]

2. Clinical cure of cancer of the larynx treated solely by roentgen irradiation has, in our experience, usually required a tumor dose of 6,000 to 7,000 roentgens given in five to six weeks. This was the dosage received by most of the 30 five year symptom-free survivors of a group of 110 patients with laryngeal cancer, treated solely by roentgen irradiation; there were no five year survivors among patients treated with a smaller tumor dose than 5,700 r in five to six weeks.[18] Calculations of these tumor doses are based on the assumption that lateral laryngeal radiation fields, anterior to the sternocleidomastoid muscle, are not farther apart than 6 or 7 cm. With fields 6 by 8 cm. and 200 kv., 50 cm. target-skin distance, and 0.5 mm. Cu filter, the tissue dose in the midline of the larynx would then be about equivalent to the sum of the air doses. This does not apply to very small fields or larger fields extending posterior to the sternocleidomastoid muscles.

3. The response of mammary cancer to increasing tumor doses of roentgen therapy in 162 patients was studied in three groups divided according to the average tumor dose used in each.[19]

(a) Total tumor doses of 400 to 2,000 r administered in several series during one year to homolateral supraclavicular, axillary, internal mammary node and mastectomy regions did not appear to alter the clinical progress of 78 patients treated by radical mastectomy and postoperative roentgen therapy. Skin recurrences in this series were noted in 9 instances and in 8 of these they occurred in the irradiated areas.

(b) The mastectomy specimens of 38 patients exposed to tumor doses of 4,500 r in one month, ending a few days to one year prior to mastectomy, showed gross disappearance of the tumor in many instances, and marked radiation damage to cancer and normal cells on microscopic examination; in every instance, however, there were also present recognizable cancer cells. These tumor doses which cause incomplete destruction of mammary cancer may nevertheless be of benefit clinically, as suggested by the experience of McWhirter,[23] of the Royal Infirmary of Edinburgh. McWhirter showed improvement in his survival figures by substituting simple for radical mastectomy and relying on a tumor dose of 3,750 to 4,500 r in three weeks to control axillary metastases. Baclesse,[1] who uses roentgen therapy alone, without surgery, has found it necessary to administer tumor doses of 6,000 to 9,000 r in four to five months, to obtain a "significant number" of five year symptom-free survivors.

(c) In the belief that our tumor doses of 4,500 r in one month were inadequate, we raised this dosage and gave tumor doses of 5,500 to 8,000 r, administered in three months, to the breast and axilla. A total of 46 patients, judged locally inoperable, though the disease was clinically still limited to the neighborhood of the breast and axilla, were thus treated solely by roentgen irradiation. Of the 46 patients, 10 remained symptom-free five years after roentgen therapy. This differs from Daland's 20 per cent five year survival in untreated mammary cancer, in that at the end of five years, these patients did not present any clinical evidence of mammary cancer, whereas Daland's patients survived *with cancer*, and this latter was five years after the beginning of symptoms and not after treatment.

4. Even in lymphosarcoma regarded as a radiosensitive neoplasm, our estimate of cancerocidal dosage had to be revised upward. During a two year follow-up, the local recurrence rate in the irradiated area was studied in a group of 72 patients with lymphosarcoma treated by varying doses of roentgen therapy. Over 80 per cent recurred locally when the total tumor dose was less than 500 r in two to three weeks;

reappearance of the tumor was noted in 20 per cent of the cases, when tumor doses of 2,000 r were given in three to four weeks; lymphosarcoma did not reappear in the irradiated area, only after tumor doses of 5,000 r in five to six weeks, administered to a few patients with lymphosarcoma, localized chiefly to the nose and throat.[20]

The four preceding examples emphasize the dependence of radiocurability on the inherent radiosensitivity of the individual cancer and show that cancerocidal radiation for most malignant growths requires high tumor doses.

RADIOCURABILITY AND TOLERANCE OF THE TREATMENT

Tolerance of cancerocidal radiation varies with resistance of the patient, with the required tumor dose and with the radiosensitivity, the vital importance and total volume of the normal tissues thus damaged.

TOLERANCE AND GENERAL HEALTH OF PATIENT

Patients suffering from debilitating diseases such as chronic heart, arterial or kidney disease, chronic alcoholism or cachexia may not support high tumor doses unless the volume of irradiated normal tissue is relatively small.[15]

TOLERANCE AND TIME FACTOR

The cancerocidal effect of radiation increases, not only with the amount of radiation reaching the tumor, but also with the speed with which the radiation is given. Except in small and superficial cancers, cancerocidal radiation is rarely given in a single exposure, but is fractionated into a number of treatments spread over a longer period of time. According to the old teachings of Regaud, this tends to reduce the damage especially to the irradiated blood vessels, connective and other normal tissues, while interfering less with the cancerocidal effectiveness of the radiation. The tumor dose, however, must be increased to compensate for recovery of the cancer between treatments and for the lessened effect of this radiation on the growth. MacComb and Quimby,[22] Strandqvist,[33] and others, have postulated rules and constructed tables suggesting the amount which should be added to make up for the loss.

The desire for milder tissue reaction led Regaud and Monod, followed by various English radiotherapists thirty years ago, to replace the formerly preferred strong linear intensities of radium tubes and needles, by those with a weaker radium content.

Coutard fractionated and protracted roentgen treatment in cancer of the upper respiratory tract over several weeks. Baclesse[2] has now extended this period to several months in an attempt to avoid the severe radioepidermitis and radioepithelitis, which was Coutard's criterion of correct dosage. In roentgen therapy of nonoperated mammary carcinomas, Baclesse now irradiates daily for three and one-half months or longer. On Dr. Blomfield's service in Sheffield, England, I saw patients with extensive mammary cancer whose roentgen therapy had been protracted for six months.

As Chairman of the Standardization Committee of the American Radium Society in 1937, I circularized the membership of the Society by questionnaire to ascertain the frequency of rectal and bladder damage observed in radiotherapy of cancer of the uterine cervix.[31] The replies showed that these complications were frequent when the time taken for intrauterine and vaginal radium therapy was shorter than thirty hours and when roentgen therapy was given in twenty days or less. Radiation injuries were less common when the treatment was spread over a longer period. Intestinal complications,[3] which appeared with alarming frequency at the Presbyterian Hospital at about this time were markedly reduced in number when the period of radium therapy was increased from the original forty hours to over one hundred hours, and the time for a series of roentgen treatments was raised from

twenty days to a period of from five to eight weeks.

Consideration of the time dose relationship should be included in planning cancerocidal irradiation.

TOLERANCE, VITAL IMPORTANCE AND RADIOSENSITIVITY OF IRRADIATED NORMAL TISSUES

The vital importance of the normal tissue injured in radiotherapy of cancer influences tolerance of the treatment. This accounts in part for the higher radiocurability rate of epithelioma of the larynx as compared to that of the bronchi; or of epithelioma of the upper, as compared to the middle esophagus. Serious sequelae of radioepithelitis in the larynx are exceptional. Radioepithelitis in the bronchi may be followed by radiation pneumonitis, lung abscess or radiation fibrosis. Recovery from radioepithelitis in the upper esophagus is usually prompt and complete. In contrast, the post-irradiation slough in the mid-esophagus may facilitate perforation of the thin esophageal wall if invaded by cancer and this may result in terminal mediastinitis. The radiosensitivity of the mucosa of the stomach and intestines usually precludes administration of adequate cancerocidal doses to malignant neoplasms invading these structures, except in very radiosensitive growths such as lymphosarcoma. Four of our 6 gastric lymphosarcomas and 3 of 4 lymphosarcomas of the rectum, treated solely by roentgen therapy, after biopsy, are well over five years.[20] There are no five year symptom-free survivors among our non-operated patients, with carcinoma of the stomach treated only by irradiation, and there are only occasional small adenocarcinomas of the rectum which have thus been arrested for a like period.

TOLERANCE OF BONE AND BONE TUMORS

Clinical appreciation of radiation injury of quickly dividing epithelium is earlier than similar damage to longer lived connective tissue, cartilage and bone. Radionecrosis of the latter three tissues may not become clinically evident for weeks, months or even years after irradiation. Infection increases the likelihood of radionecrosis, though non-infected tissues may also undergo radionecrosis. Thus, osteomyelitis and osteo-radionecrosis may follow extraction of teeth from the upper maxilla and especially from the mandible, a long time after these bones have been exposed to cancerocidal irradiation, *e.g.*, in radiotherapy of oral carcinoma. Extraction of bad teeth and dental hygiene should therefore precede, perhaps by ten days or two weeks, the administration of cancerocidal irradiation to the jaw, so as to allow healing of the bone before it is exposed to severe radiation injury. According to Woodard and Coley,[36] normal bone is likely to be completely devitalized by tissue doses of 5,000 roentgens in four weeks. Nevertheless, bone thus irradiated may at times withstand the ordinary strains and stresses of life without breaking down. This tumor dose was administered to a Ewing's endothelioma in the distal end of the humerus of an adult, treated by roentgen rays after a biopsy at the Presbyterian Hospital, eight years ago. The patient is well and there is no clinical or roentgen evidence of bone injury at present. Another Ewing's endothelioma of the upper end of the femur was controlled for five years by a tumor dose of 5,000 r, given in six weeks. The tumor reappeared in the original site at the end of five years, but there was no evidence of bone damage. Preceding injury to bone increases the likelihood of radionecrosis. A tumor dose of 5,000 r in six weeks completely destroyed a chondrosarcoma of the mandible in one of our patients now well eleven years after irradiation. The bone had been curetted a few weeks before radiotherapy and broke down six months later. Woodard and Coley found complete devitalization of bone tumors with the following tissue doses given in four weeks: 1,500 to 3,000 r for giant cell tumors, 3,000 to 4,000 r for reticulum cell sarcoma,

6,000 r for Ewing's endothelioma and 8,000 r for osteogenic sarcoma.

Tolerance of adequate tumor doses for local regression of secondary involvement of bone is also influenced by the inherent radiosensitivity of the tumor. Among 29 malignant tumors of the nasopharynx invading the base of the skull and treated by roentgen irradiation at the Presbyterian Hospital,[21] there were 10 patients with lymphoepithelioma and 9 with differentiated epithelioma; 5 of the former and none of the latter remained symptom-free five years after treatment.

TOLERANCE AND VASCULARIZATION

Tissue tolerance is affected by poor vascularization. Tissues, the blood supply of which has been damaged or which have been scarred by previous disease, operation or repeated intensive radiotherapy, are unable to withstand cancerocidal irradiation and break down readily if exposed to high radiation doses. Excision is better than radiotherapy in cancers arising in poorly vascularized scars, after operations, flame burns, lupus vulgaris, etc., and in cancers growing in previously irradiated atrophic or telangiectatic mucosae or skin. In irradiation failures, excision is preferable to retreatment with cancerocidal radiation doses to the formerly irradiated areas because intensive radiotherapy in these cases is rarely successful and often results in painful and non-healing radionecrosis. Inclusion of even a narrow zone of heavily irradiated tissue may give rise to radionecrosis starting at the junction of the previously and newly irradiated fields. Repeated exposures of malignant neoplasms to weak radiation doses increases fibrosis of the tumor and makes it less radioresponsive. Thus, an inguinal lymphosarcoma failed to regress when given a tumor dose of 3,000 r in three weeks, after it had been exposed to small doses twice weekly for several months, by another radiotherapist.

TOLERANCE AND INFECTION

Repeated infection of a cancer may also cause increased fibrosis and result in lessened radiation response even in an otherwise radiosensitive lymphosarcoma: A tonsillar lymphosarcoma which had been repeatedly incised under the wrong diagnosis of quinsy, regressed only slightly after a tumor dose of close to 3,000 r in three weeks. Cancerocidal irradiation is not well tolerated by infected, inflamed tissues. Cancerocidal doses are not bactericidal and may increase the severity of infection by necrosis of the inflamed tissues. This may cause grave complications, if drainage is inadequate: *e.g.*, it may give rise to peritonitis in radium therapy of carcinoma of the cervix uteri complicated by pyometra; it may cause distention of the maxillary antrum if a carcinomatous radiation slough blocks the exit. The relationship between infection and osteoradionecrosis of the mandible has been discussed above. If possible, infection should be cleared up, before initiating cancerocidal irradiation, by antibiotics, surgical drainage or in certain cases by a preliminary series of weak roentgen-ray doses.

TOLERANCE AND IRRADIATED VOLUME

Tolerance of radiotherapy decreases with increasing volume of normal tissues exposed to radiation in order to treat the growth, or in other words, with increasing extent of the cancer. For instance, the average dose used in total body roentgen therapy or in treatment with radioactive phosphorus or sodium is usually less than 100 r in a week, though larger doses have been supported. While such doses may be useful for temporary growth restraint, they cannot be regarded as cancerocidal. When larger volumes of tissue are irradiated, the total energy absorbed by the body, as a whole, should be computed by the integral dose, the unit of which is the megagram roentgen.[25]

The volume of irradiated normal tissue becomes greater with increase in the size and number of irradiated fields, with greater focal distance and with greater power of the radiation.

TOLERANCE AND SIZE OF THE IRRADIATED FIELD

Decrease in the size of the irradiated field increases tolerance for radiation damage. This has been re-emphasized by recent experiments on mice[6] and by clinical trials.[7,10,24] A tissue dose of 24,000 r to a 1 cm. field on the back of a mouse, has been administered in one exposure with recovery of the irradiated skin, by Anna Goldfeder.[6] In treating cancer patients, Hirsch Marks[24] has administered 24,000 r in air in twenty exposures, five days weekly, for four successive weeks. The radiation fields varied from 50 to 150 sq. cm. and were subdivided into 1 cm. squares or circles, with intervening shielded areas. In this "grid method" of roentgen therapy only 40 per cent of the field is exposed to direct radiation, while 60 per cent is shielded and receives only scattered radiation. The small size of the fields exposed to direct radiation permits recovery of the skin in these areas, in spite of the high doses, as epithelialization starts from the edges of the shielded areas and spans across the more severely injured directly irradiated field. The distribution of this type of radiation is comparable to interstitial irradiation with radium needles and is not homogeneous. Evaluation of grid therapy will take several years; the early clinical results are encouraging. It is doubtful, however, whether the high daily intensities originally recommended will be retained, because of damage to the connective and other normal tissues, already evident now.

TOLERANCE AND THE USE OF MULTIPLE FIELDS

In crossfiring of deep-seated lesions through several opposing fields, the normal tissues traversed in reaching the tumor are exposed to only a fraction of the radiation they would receive if the same tumor dose were administered through one or two opposing fields. The radiation damage which these tissues must support is therefore reduced and radiotherapy through such radiosensitive tissues as pulmonary parenchyma or intestinal mucosa is tolerated more readily. Mayneord and Smithers[32] have crossfired pulmonary cancer by directing radiation obliquely through multiple fields arranged in a circle, on the anterior or posterior aspect of the chest, so that all beams cross below the surface, at the site of the lesion. Some manufacturers have applied this principle to the construction of roentgen therapy apparatus. In this, the roentgen tube is rotated on a metal circle attached to the roentgen-ray head and the beam is directed at a central focal point, at the desired depth below the surface.

In rotation therapy, most of the radiation is received by the axis around which the beam is rotated, as this is constantly exposed to the beam. The tissues peripheral to the axis receive less, being exposed only part of the time; the farther they are from the axis, the less they receive, as they are rotated through the beam more rapidly. For instance, if the theoretical axis in rotation therapy for cancer of the esophagus or cervix uteri is placed through the center of the lesion, most of the radiation will be received by the central portion of the tumor and least by the skin and superficial tissues. The same holds true for eccentrically placed tumors, *e.g.*, pulmonary cancer. The variation in distance between the target and the contours of the body, while the patient is being rotated through the beam, does not interfere too much with calculation of the tissue dose, as inequalities are corrected by the crossfiring through the opposing fields. Dessauer,[4] Hawley,[11] and Nielsen[26] have used rotation therapy with 200 kv., while Hare *et al.*[9] have more recently applied this principle to 2,000,000 volt radiation.

TOLERANCE AND VOLUME OF IRRADIATED TISSUE IN SUPERVOLTAGE, ELECTRON AND NEUTRON BEAM THERAPY, INTERSTITIAL AND INTRACAVITARY IRRADIATION

The increase in volume of irradiated normal tissues beyond the lesion must be considered when using supervoltage, especially in the range beyond 2 million volts.

Clinical application of electron and neutron beam therapy in deeply situated cancers still awaits the perfecting of apparatus and more accurate dosimetry. The hope has so far not materialized that by electron beam therapy with multimillion voltage, it will be possible to confine radiation injury to a single layer of tissue at the desired depth.

In intracavitary and interstitial irradiation of cancer, the volume of normal tissues unavoidably damaged is reduced to a minimum. The anatomic location and extent of cancers irradiated by this method must permit accurate placement of radiation sources in close proximity to the growth; this is essential because of the rapid decrease of radiation intensity with increasing distance from the source, according to the inverse square law. Cancers which are naturally accessible, *e.g.*, in the oral and cervical cavities, or those made accessible by operative exposure, are most suitable for this approach.

It is evident from the preceding discussion that tolerance of cancerocidal irradiation varies with the inherent radiosensitivity of the irradiated normal tissue. Tolerance decreases with increasing radiation delivered to the tumor and with shortening of the time used to deliver this dose. These basic laws hold true for the normal tissues in the immediate neighborhood of the cancer, irrespective of whether the radiotherapy is administered by low, high or super voltage, through a single field, multiple fields, grid or rotation therapy, radium beam or intracavitary or interstitial radium or radon therapy. The radiation injury of the tissue near the growth is always the same, no matter what form of local cancerocidal radiotherapy accounts for the overdosage. The difference is found in the location and the anatomic extent of this injury—corresponding to the distance to which these various forms of radiation penetrate. The seriousness of radiation injury becomes greater with increase in the volume of normal tissue damaged.

Attempts to reduce to a minimum the volume of normal tissues exposed to cancerocidal doses has led to the use of radiation fields restricted as much as possible to clinically involved areas. This has reemphasized the need for accurate localization of the cancer based on clinical knowledge of the location and extent of the disease and has also stressed the importance of the hospital physicist for selection of the best physical factors for delivery of the desired tumor dose.

RADIOCURABILITY AND RADIATION PHYSICS

Though the influence of physics in raising the accuracy of dosimetry and exact application of radiation is generally accepted, few radiotherapy departments in the United States can boast of a hospital physicist who is an integral member of the radiotherapy staff and is consulted on routine treatment cases. This is unfortunate, as too often the lack of appreciation of the physical factors concerned in radiotherapy of cancer accounts for the failure of this treatment. We need hospital physicists and should encourage young physicists to go into radiation physics by making the position of the hospital physicist attractive from scientific, staff and financial standpoints. They should instruct the medical staff in radiation physics, check all technical equipment and radiation output, help to calculate tumor dosage and select the best physical approach for delivery of the desired cancerocidal dosage.

Calculation of tumor dosage is meaningless unless the beam has been accurately directed. Under the influence of and in collaboration with hospital physicists, methods for increasing precision of beam direction have been developed. Thus, there have been mounted on roentgen-ray and radium beam heads, scales and backpointers to indicate the angle of incidence and exit of the beam. Protractors and the pin and arc are of help, especially, where compression is desirable, when the patient is lying prone and where backpointers are not practical. Maintenance of the patient in position and

repetition of the set-up has been facilitated by various devices: This has been done by special holders attached to the treatment table.[35] Plaster of paris or plastic molds have been fitted to the contours of the body and raised wax outlines of the radiation fields fixed on the outer surface of these molds. The size and position of these fields are based on carefully calculated considerations of the best approach for delivering the desired tumor dose.[27]

Correct clinical localization of the cancer is of course a prerequisite for accurate beam direction and emphasizes the fact that radiotherapy of cancer is primarily a clinical treatment, in which the help of the physicist can start only after the location and extent of the cancer has been determined clinically. Monod, from whose clinical records Paterson and Parker constructed their original tables of radium dosage, did all of his work on an empiric clinical foundation, yet his survival statistics in cancer of the tongue and cervix uteri were as good as those obtained at present. Coutard, on whose clinical irradiation method modern roentgen therapy of cancer rests, determined cancerocidal dosage solely by his clinical judgment, guided by daily observation of the radiation in the patient. He did not have a preconceived plan of treatment based on physical measurements, yet his radiocurability rate on the whole, has not been surpassed. Neither Monod nor Coutard, who learned dosimetry by clinical trial and error, could transmit their knowledge of dosage to others, except to those who had the privilege of working with them for a long time. The great advantage of dosage tables and physical standards is that they give one a firm physical basis to build on. A knowledge of physics, however, is not enough and clinical experience with radiotherapy of cancer is essential.

Cancerocidal radiation, except in very radiosensitive cancers requiring relatively small tumor doses, injures capillaries, causes endarteritis, sclerosis of the connective tissue stroma, as well as damages other normal tissues. Severe radiation injury of the nourishing capillaries may prevent epithelialization after radioepithelitis and result in a "roentgen burn." Even if it does heal, recovery from this injury is usually incomplete and tolerance for further radiation is lowered. Radionecrosis may result if such tissues are again exposed to cancerocidal radiation. It is therefore of paramount importance that clinical localization and radiotherapeutic technique be correct the first time the cancer is exposed to cancerocidal dosage, because errors committed during this first treatment cannot be corrected later by better irradiation technique. The responsibility of a doctor attacking a cancer with cancerocidal irradiation for the first time is indeed great, as tissue tolerance for this dosage is never again as good as during the first treatment period.

Radiocurability, Training, Experience of the Radiotherapist and Care of the Individual Patient

The likelihood of accurate clinical localization of the cancer, of correct radiotherapeutic technique and of radiocurability increases with the expertness of the radiotherapist and the time he devotes to the individual cancer patient. For instance, the high radiocurability rate attained by Coutard and Monod at the Curie Foundation of Paris was due chiefly to expert individual care and time they gave each patient. Their expertness was based on long personal experience, clinical judgment and meticulous attention to detail. Their results were accomplished without the help of modern physics, new equipment or a large staff of assistants. Coutard personally examined and installed every patient for each roentgen-ray exposure, twice daily, noting his findings in writing, drawings and diagrams; because of the individual care he gave each patient, he treated less than 100 patients per year while working at the Curie Foundation. Such time-consuming personal attention by an expert, though desirable, would be impractical in a busy

general radiotherapy department, unless there is available an adequate staff of well trained radiotherapists who can give the time needed to the individual patient. It is a mistake to intrust radiocurable cancer patients to the unsupervised care of inexperienced interns or, what is worse, to lay technicians. They do not have the necessary clinical experience or judgment to choose correct radiotherapy technique, or to appreciate clinical changes which may influence such factors as daily and total dosage, etc. They do not know how to administer individualized radiotherapy, but give only the routine type of treatment, which shortcoming in some instances may make the difference between success and failure of the treatment. There is no substitute for thorough training and long clinical experience with radiotherapy of cancer. This type of preparation is essential for good radiotherapy, takes time and profoundly influences the clinical results obtained by the doctor treating the patient. Radiocurability of cancer patients is higher in radiological services which have specialized in this treatment than in those clinics where cancer is irradiated occasionally. Improvement in cancer statistics has occurred principally in those radiation centers in which the same radiotherapy staff has repeatedly dealt with similar cancers over a period of years.

Surgery of cancer improved with the development of regional surgery. The same would hold true if we were to develop regional radiotherapy. A number of radiotherapists have already emphasized one or another anatomic subdivision of radiotherapy in which they have done special work and have become known for this "specialty within the specialty." There is no question that the clinical results of these "super-specialists" are better than the average for the group. They know the disease and how best to overcome the difficulties of its treatment by radiation. Cancer teams consisting of regional surgeon and regional radiotherapist working jointly in new patient and follow-up clinic of a cancer hospital develop keen appreciation and unbiased opinions of the advantages and shortcomings of each other's method of treatment. Cancer teams in special or general hospitals are a step in the right direction, but may not have the experience resulting from the large aggregation of clinical material, nor the costly radiotherapy and other equipment available in cancer hospitals.

Three categories of doctors administer radiotherapy to cancer patients in the United States:

There are few radiotherapists who devote their entire time to radiotherapy. The proportion of cancer patients they treat is relatively small.

A larger number of patients with cancer are irradiated by surgeons who also do radiotherapy. Their chief training and interest is surgery and little time is therefore left for the study or practice of radiotherapy. Their radiation treatment is too often of the routine type, hurriedly fitted in between operations and does not yield satisfactory results. The frequency of failure and the rarity of clinical cures from their therapy finally cause them to lose confidence in this treatment and to limit radiotherapy to preoperative or postoperative treatment or to the care of inoperable and usually incurable patients. There are, of course, outstanding exceptions to this generalization among gynecologists, head and neck and other regional surgeons who not only have adequate training, but have contributed richly to our knowledge of radiotherapy of cancer. On the whole, however, most of the men starting out to do surgery and radiotherapy, sooner or later end up by emphasizing one of these specialties, usually surgery, and neglect the other.

By far the largest proportion of irradiated cancer patients in the United States are treated by radiologists primarily interested in roentgen diagnosis, but also doing some radiotherapy. Of the three year training period required by the American Board of Radiology for admission to exami-

nations for certification, only one year is usually spent in Radiotherapy. Candidates may qualify in roentgen diagnosis and therapy without being certified in radium therapy. Dr. Corscaden, Chairman of the Education and Publicity Committee of the American Radium Society in 1948, sent questionnaires to the executive officers of forty universities and medical schools, inquiring as to the details of training in radium therapy in their departments. Of the twenty-nine chiefs of radiological departments who answered, nine did not use radium. Of the remaining twenty university departments where radium was used, formal education in the use of radium was given in only two instances. Many radiologists who administer roentgen therapy to cancer patients are not trained in the use of radium and do not employ it. In England, where radiotherapy is completely divorced from roentgen diagnosis, qualification in radiotherapy includes certification in the therapeutic use of radium, radioactive substances and isotopes as well as in roentgen therapy. The Board of Radiotherapy demands that before being admitted to the qualifying examination, the candidate for a diploma in radiotherapy spend two years in clinical radiotherapy, including six months in physics, in addition to at least one year's general internship. Fellowships in the Faculty of Radiotherapy require another three years of clinical radiotherapy, *i.e.*, a total of five years. This is four years longer than is required from fellows qualified in radiotherapy by the American Board of Radiology. According to a summary on page 40 of a "Report by a Delegation from the British Empire Cancer Campaign, on a Visit to Canada and the United States of America in 1948,"[30] "Radiotherapy in the United States has not developed in the same way as it has done in Great Britain and as a generalization has not at the present time such an important place in the treatment of cancer. There are few radiotherapists who have adequate training, experience and the opportunity of using both x-rays and and radium, and there is a tendency for radium therapy to be used much less than in this country. The general standard of techniques of treatment, measurement and assessment of dosage are generally on a much more empirical and less exact basis."

Various reasons have been advanced for our shorter training period in radiotherapy and for the need of qualifying general radiologists in the United States. It is said, for instance, that small towns expect a radiologist to do both roentgen diagnosis and therapy, as there is not enough work to support men doing only radiotherapy. Many indigent cancer patients would undoubtedly remain untreated if they could not receive radiotherapy in their own locality, and the local radiologist does as well as he can. Yet is that the best that can be done for the patient? Though incurable cancer patients may not do better in expert than in less expert hands, an expert at times may cure a patient classified as incurable by the less experienced doctor, and thus justify the extra effort needed to obtain expert radiotherapy. Transportation for indigent cancer patients to free radiotherapy centers in larger cities could be paid for by state or voluntary funds. Regaud, the father of modern radiotherapy of cancer, when confronted with a similar problem in France, pointed out that it is easier to transport a cancer patient to an institution where the necessary skill, experience and equipment are available, than to supply an adequate number of expert radiotherapists for cancer patients in outlying districts. Modern automobile, rail and air travel in the United States facilitate the application of Regaud's ideas to our own country.

Many roentgen diagnosticians sincerely believe that joint administration of roentgen diagnosis and therapy is more efficient[12,13] than it would be if the two were separated. Some of these men have greatly expanded the radiotherapeutic facilities of their departments to include all modern technical developments. They feel that they

can manage both roentgen diagnosis and therapy by delegating radiotherapy to carefully chosen associates. Though these associates take over the conduct of radiotherapy, they are, nevertheless, guided by the wishes of their chief who, while he is an expert in roentgen diagnosis, is untrained in the radiotherapy of cancer. It seems logical that administration is better if carried out by an expert in the field being administered. One individual, however, cannot be expected to be an expert in roentgen diagnosis, and at the same time know the characteristics of regional cancer, keep up with modern advances in supervoltage, electron and neutron beam therapy, radioactive isotopes, etc. Why would it not be better to have one chief for roentgen diagnosis and one for radiotherapy? As a matter of fact, experience in England, Scandinavia and in the few institutions in the United States in which radiotherapy has been separated from roentgen diagnosis, has shown that the two departments function better when each is independent. The truth that roentgen diagnosis and radiotherapy each is a full time job and should be separated should be appreciated especially by those men who have worked so hard to raise the standard of American roentgen diagnosis to a level not surpassed in any other country.

According to Windeyer,[34] over 60 per cent of all cancer patients in Great Britain receive radiotherapy at one time or another, and the proportion of cancer patients irradiated in our country is probably as high. A great deal of effort and money are spent in the United States on propaganda for early diagnosis and treatment, but relatively little for the training of expert radiotherapists. This is unfortunate as there are still too many cancer patients, including early radiocurable cases, who are not cured by radiotherapy, simply because of the lack of training and experience of the radiotherapist to whom they apply for treatment. The radiocurability rate of cancer in the United States could be rapidly raised if we increased the number of fully qualified radiotherapists. A number of promising young doctors, with an appropriate background for special training in radiotherapy of cancer, should be selected and trained in recognized radiotherapy centers. During their training period, these men should be supported financially, if necessary, and thereafter should be placed in radiotherapy departments in various parts of our country in order to raise the level of radiotherapy in the United States.

The level of radiotherapy in England rose distinctly once roentgen diagnosis and radiotherapy were separated. A similar change for the better took place in the Scandinavian countries when radiotherapy became independent. In 1937, Forssell[5] and, more recently, two members of the American Board of Radiology, Quick[29] and Portmann,[28] have recommended the separation of these two radiological specialties. The time has come when the advisability of such a separation and how best to effect it should be made a subject for a combined study of all governing radiological bodies in the United States and thus raise the level of American radiotherapy to one that will be equivalent to that of American roentgen diagnosis.

CONCLUSIONS

Radiocurability and the technique of radiotherapy of cancer are influenced by two sets of factors: The first set includes the natural clinical course of the untreated cancer, its location, extent and radiosensitivity and the patient's tolerance of the required cancerocidal dosage. The second considerations concern the training and experience of the radiotherapist, and the time, attention and care he is able to give the individual patient. The first set of factors is well known and is being improved; the need for longer clinical training and experience in radiotherapy of cancer is not fully appreciated.

Radiocurability of cancer in the United States could be increased by lengthening the training period in radiotherapy re-

quired from candidates for certification by the American Board of Radiology and by recognizing radiotherapy as a separate and distinct specialty. This change would be in the interest of the cancer patient and would tend to raise the level of radiotherapy in the United States of America.

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ROENTGEN THERAPY IN CANCER OF THE LARYNX AND HYPOPHARYNX*

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THE primary objective of this paper is to present a correlation between survival rate and anatomic site of origin in cancer of the larynx and hypopharynx in which the primary treatment was by roentgen therapy.

The secondary objective is to show the relation between the above to the extent of the disease, together with certain common signs and symptoms which are of important prognostic significance.

Precise localization as to the anatomic site of origin and the extent of the disease affects profoundly the prognosis as to the survival and functional restoration that can be anticipated when this method of treatment is employed.

The clinical and pathological features of the disease have been amply discussed by Ackerman and del Regato,[1] Cutler, Buschke and Cantril,[2] Harris, Kramer and Silverstone,[3] Martin,[4] and many others. The problem of a generally acceptable, satisfactory classification has been discussed at length by these same authors. It is not the purpose of this paper to discuss classification. The material will be presented in such a fashion that any combination of anatomical sites may be used to suit the concept of the reader, depending upon what he considers the larynx.

The clinical material for this paper consists of 92 cases of cancer originating in the hypopharynx and larynx in which the primary treatment was by roentgen therapy, during the years 1933 to 1950 inclusive.

All cases seen and treated during that period in which the histopathologic diagnosis was established are included. All of these cases are histopathologically squamous carcinoma. The material consists of clinic cases referred from the Episcopal Eye, Ear, Nose and Throat Hospital, the Warwick Memorial Clinic and private cases referred to the late Dr. E. A. Merritt and the author.

The vast majority of cases included in this report have been carefully studied from the standpoint of history, physical examination, roentgenographic studies and repeated examinations during and after treatment by members of the staff particularly interested in the problem.

Sixty-three cases were treated prior to 1946, and thus available for evaluation in terms of survivals of from five to sixteen years.

The anatomic sites of origin of all lesions except the posterior pharyngeal wall are shown in Figure 1. The character of the material and results of treatment are shown in Table 1.

DISCUSSION

True Cord. For the purpose of this paper, all subglottic lesions are included as variants of true cord cancer, as proposed by Martin.[4] It will be noted in referring to Table 1 that the survival rate was 78 per cent in early lesions and only 33 per cent in advanced lesions. Two patients with early true cord lesions died without evidence of disease in the fourth year.

The following criteria to differentiate early and advanced true cord lesions are used:

The symptoms of *early* true cord cancer consist of hoarseness only.

Advanced true cord cancer may have any one or several of the following symptoms:

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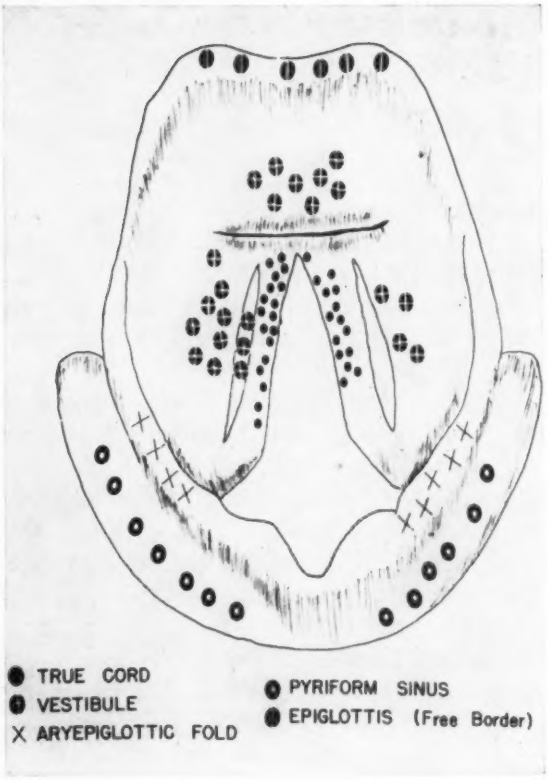

FIG. 1. Diagrammatic sketch of the mirror image of the larynx and pyriform sinuses showing topographic distribution of all cases except the posterior pharyngeal wall.

Constant progressive hoarseness, local pain, otalgia, dysphagia, dyspnea, hemorrhage and extralaryngeal edema.

The physical findings in early true cord cancer consist of a tumor confined to one or both cords, without fixation or edema, regardless of the extent of the disease. When true cord cancer becomes more advanced, any one or several of the following signs are found:

Extension of the tumor beyond the cord or cords, fixation, edema, local tenderness, diminished airway and, rarely, cervical lymph nodes.

It will be seen from the above that the only criterion from the standpoint of an early lesion was the lack of fixation, indicating infiltration. Actually, many of the early lesions judged by this criterion were sufficiently far advanced to require at least a partial, and in many cases, a total laryngectomy for cure.

Vestibule. This category included all cases having origin in the ventricular cavity, false cord, and laryngeal face of the epiglottis below the level of the hyoid bone. Vestibular cancer is capable of assuming relatively voluminous proportions before producing symptoms. As a consequence of this, most of the cases present as advanced cancer.

The following criteria for early and advanced stages of the disease have been followed:

Symptoms in early vestibular cancer may be absent or consist of mild local pain, hemorrhage and hoarseness, which may be intermittent.

Symptoms of advanced disease consist of any one or several of the following:

Accentuation of the early symptoms, dysphagia, cervical lymph nodes, edema, otalgia and dyspnea.

The physical findings in early vestibular cancer demonstrate a supraglottic tumor with no edema, fixation, nodes or local tenderness. Advanced disease may show any one or several of the following signs:

Fixation, local tenderness, nodes, edema and tumor extension beyond the larynx and obstruction to the airway.

A cure rate of 25 per cent in early lesions in this series is probably not representative of the true state of affairs. More recent cases in my experience, and from material seen elsewhere, leads me to believe that early cancer originating in the laryngeal vestibule is readily curable providing the diagnosis can be established at an earlier stage.

Free Border of the Epiglottis. Cancer originating on the tip or free border of the epiglottis in all cases has presented as advanced disease with local pain, indicating necrosis and/or dysphagia or odonophagia. Local extension to the vallecula, base of the tongue and pharyngoepiglottic fold and cervical lymph nodes were common features. The roentgen examination is quite characteristic. As indicated in Table 1, 6 cases were treated with no five year survivals.

Aryepiglottic Fold. The aryepiglottic fold

or so-called "party wall" separates the functional pharynx from the larynx. Nine cases originated from the free margin of this structure. The majority of cases developed symptoms referable to both pharynx and larynx, almost simultaneously as one would expect from the location of this anatomic structure. Strangely enough, all

The following facts emerge from the 13 cases in the clinical material herein presented:

1. The initial symptom in all cases was referable to the alimentary tract; *i.e.*, dysphagia or odonophagia.

2. All but 2 of the 13 cases developed hoarseness prior to treatment.

TABLE I

RESULTS OF ROENTGEN THERAPY AS A PRIMARY METHOD OF TREATMENT IN THE VARIOUS SITES OF ORIGIN OF CANCER IN THE LARYNX AND HYPOPHARYNX

	TRUE CORD		VESTIBULE		EPIGLOTTIS FREE BORDER	ARYEPIGLOTTIC FOLD	PYRIFORM SINUS (Postcricoid)	POSTPHARYNGEAL WALL
	Early	Advanced	Early	Advanced				
	●		⊕		⊖	X	⊙	
TOTAL CASES *prior to 1951*	21	12	5	18	6	9	13	8
TOTAL CASES *prior to 1946*	16	6	4	9	6	6	10	6
INDETERMINATE	2	0	0	0	0	0	1	0
1. UNTRACED	0	0	0	0	0	0	0	0
2. DEAD-N.E.D. *(under 5 yrs.)*	2	0	0	0	0	0	0	0
3. TREATMENT NOT DEFINITIVE	0	0	0	0	0	0	1	0
DETERMINATE	14	6	4	9	6	6	9	6
5 yr. SURVIVALS	11	2	1	1	0	1	1	0
5 yr. SURVIVALS %	78%	33%	25%	11%	0%	16%	11%	0%

were quite far advanced cancer from the standpoint of local extent of the disease. This would hardly seem possible in a structure so closely associated with the vital functions of voice and deglutition.

All exhibited a marked primary radiosensitivity but the low survival rate, *i.e.*, 6/1 (16 per cent), is probably an index to the inability to establish an early diagnosis.

Pyriform Sinus (Postcricoid). One might properly question the interchangeable usage of these terms. Theoretically, postcricoid cancer must originate on the posterior aspect of the "party wall" and, as such, could be considered as a part of the true anatomical larynx.

3. Twelve of the 13 cases presented as advanced cancer either by virtue of local extent of the disease and/or cervical lymph nodes.

4. Two of the cases had symptoms of dysphagia *only*. One of these was quite early, and the patient survived seven years after treatment, dying of intercurrent disease.

5. In *no* case was a five year survival obtained when the patient presented with symptoms of both hoarseness and dysphagia.

It would seem from the above facts that cancer developing in this anatomic site offers a relatively poor prognosis from the

standpoint of roentgen therapy unless one is confronted with an early lesion such as my only single cured case.

Posterior Pharyngeal Wall. The clinical material consists of 8 cases originating on the posterior pharyngeal wall between the levels of the arytenoid cartilage and the hyoid bone. Most of them were obviously advanced cancer. The survival rate is most depressing. Not a solitary "cure" has been obtained in this group.

TECHNIQUE OF TREATMENT

All of these cases were quite well treated from a technical standpoint, judged by present standards. All cases received estimated tumor doses of the order of 5,000 to 5,600 roentgens, in from twenty-one to thirty-six days. The average treatment time has been, and continues to be, twenty-six to thirty days.

Prior to 1939, all cases were treated with apparatus generated at 220 kv. (peak), Thoraeus filter equivalent to 2 mm. Cu, half value layer 2.06 mm. Cu, at 50 cm. target-skin distance. During that time, bilateral opposing fields of the order of 7 by 7, to 10 by 10 cm. were used, depending upon the extent of the disease.

Since 1939, the following factors have been used: 400 kv. (peak), 75 cm. target-skin distance, filter 1.0 mm. Cu added, half-value layer 3.0 mm. Cu. The field sizes have been much smaller, particularly in early true cord lesions, where it has been found that fields of the order of 5 by 5, or 5 by 6 cm. can be utilized. A light beam localizer of the del Regato type is used. All patients are treated in the lateral decubitus posture, securely supported by sand bags in order to prohibit motion.

In early unilateral true cord lesions, a single lateral field has proven adequate and I believe desirable. I have the very definite impression that the morbidity during and after treatment due to edema, severe mucosal reactions, etc., is materially lessened when a single field is utilized. Obviously, in the more advanced lesions, it is necessary to resort to bilateral opposing fields.

SUMMARY AND CONCLUSIONS

1. Non-infiltrating cancer originating on the true cord is curable in a high percentage (78 per cent) of the cases, regardless of the extent of the disease.

2. Advanced cancer in the hypopharynx and larynx, regardless of the site of origin, offers a poor prognosis from the standpoint of roentgen therapy.

3. Patients requiring a previous tracheostomy offer a poor prognosis.

4. Symptoms of hoarseness and associated dysphagia are exceedingly poor prognostic signs, regardless of the anatomic site of origin.

5. The survival rate in all patients with cancer producing dysphagia only is very low.

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DISCUSSION

DR. WILLIAM HARRIS, New York, N. Y. Dr. Caulk has clearly presented his objective in his presentation. He showed that there is a correlation between the survival rate and the anatomic site of origin in cancers of the larynx and hypopharynx when the primary treatment is roentgen therapy. Dr. Caulk has further made a correlation between symptomatology and prognosis in the various anatomical sites that are invaded by cancer of the larynx.

A plan of this kind carried out on larger numbers of patients may significantly indicate the preference for the type of treatment that will best suit the patient. He has not used the conventional forms of classification and has rather designated the types of lesions by the anatomical site of origin. This is not always possible,

especially where more than one site is involved and where it is difficult to definitely state the exact point of origin. Although Coutard and others have stated that, as the lesion regressed, one could determine the site of origin, it is doubtful whether this will hold in most of the patients. If one were to divide his patients into the classification that is so commonly used in this country, namely intrinsic and extrinsic, he shows quite definitely that the prognosis when roentgen therapy is used is very excellent in the intrinsic lesions. The results from roentgen therapy in the so-called extrinsic lesions is naturally worse, and is especially so when there is lymph node involvement. Lesions of the extrinsic larynx are usually much more extensive and are often accompanied by fixation of the structures. It is in this group of patients especially that a lesson may be learned from the experience of Baclesse of the Curie Foundation who, in recent years, has protracted the treatment to sixty, seventy or even to ninety days. An indication of this trend was made in the discussion of the previous papers by Drs. Lenz, del Regato and Charles Martin where they stressed the factor of over-all time and greater protraction.

In our recent experience with these extensive lesions we have found that this greater protraction is giving us better results in the more advanced extrinsic lesions.

There can be no question about the serious reactions which accompany treatment within thirty or forty days and the serious morbidity will be significantly reduced when greater protraction is employed.

Dr. Caulk has further indicated in his technical factors which have been used since 1939 the general trend towards the use of smaller portals, namely 5 by 5 or 5 by 6 cm. The use of a single portal, however, is unique and should be adequate for small intrinsic lesions, but for more extensive lesions he follows the conventional method of bilateral portals.

Dr. Caulk's study clearly shows that patients with early intrinsic cancer of the larynx can receive good results from roentgen therapy. The method of choice, whether surgery or roentgen therapy should be used in the more advanced and extrinsic cases, will only be determined by further experience.

Dr. Maurice Lenz, M.D., New York, New York. May I ask Dr. Caulk whether he has had any experience with having cancers of the pyriform sinus radically resected. Roentgen therapy of these cancers has given very poor results in my experience and any help in treating these cases would be most welcome.

Dr. John S. Derr, Frederick, Maryland. It may seem very presumptuous of me, in view of the presentation that Dr. Caulk has made, to report one case but it just happens to be the first case that I have had in forty years in the practice of radiology.

D. H. C., male, aged seventy-four, came to me suffering from a laryngeal condition of two years' duration. He had been treated by two specialists. He was assured by one that he had no carcinoma. His symptoms were distressing; he had frothing at the mouth, hoarseness, pain in the side of his neck, and difficulty in swallowing. I sent him to one of these men for biopsy, which he made, and reported that he found squamous cell carcinoma of the left arytenoid.

The question of operation was discussed with the patient. He already had had a heart attack and he said he would die rather than have an operation for removal of his larynx, so roentgen therapy was decided upon. Technique 190 kv., 50 cm. distance, 0.75 mm. Cu plus 1.0 mm. Al as filter, 10 by 10 cm. area, through each side, alternate days, 170 r to the area for twenty-six visits, from March 26 through April 14, 1951. He developed a moderate skin reaction which healed without scar.

When last seen on July 17, 1951, he was clinically well and working; dysphasia and hoarseness had cleared up and he felt perfectly comfortable. Examination by the specialist who made the biopsy revealed no evidence of malignancy.

I hope this case will fall in the class that Dr. Caulk has mentioned as giving good results from roentgen therapy.

Dr. Caulk (closing). I want to thank all the discussants. With regard to Dr. Harris' question about the possibility of classifying advanced cancer in this area, as to site of origin, I want to say a few words. When one is presented with an advanced cancer with symptoms of both hoarseness and dysphagia, it is only necessary to ask the patient which came first, the hoarseness or the dysphagia, and I have always found the patient to be quite positive as to the sequence of these events. If the patient reports that the dysphagia came first, then one can be sure that the lesion started in the pyriform sinus or on the pharyngeal side of the party wall. If the primary symp-

tom was hoarseness, then one can be sure that it must have begun in the larynx proper. If the two conditions came on almost simultaneously, in a matter of a week or two, let us say, it almost surely must have begun on the aryepiglottic fold and this can be confirmed by the examination.

If the lesion is very small and confined to the true cords, and the symptoms are only hoarseness, you know that it must have begun on the true cord. On the other hand, if it should prove to be a large, bulky tumor with a history of hoarseness only for a short period of time, it must be of vestibular origin.

These are a few of the simple things that I think are very important in trying to determine the site of origin in advanced lesions.

As to the question about surgery in the more advanced extrinsic lesions, and discussion relative to extreme protraction, I can only say that I am not particularly optimistic about the possibilities of control even with extreme protraction of treatment. It so happens that I am working with a group here in Washington that is doing some radical surgery on advanced laryngeal cancer of the type that has been done at the Memorial Hospital in New York. In the last nine months we have had several cases at the Episcopal Hospital in which surgery has been done on hypopharyngeal wall and pyriform sinus lesions. I have seen these cases following surgery and the surgery, while radical, has in several of the cases produced palliation at least that has been far better than I have ever been able to accomplish with roentgen therapy. Actually this type of surgery is relatively new and not enough has been done to evaluate the results in terms of survivals. It is drastic, expensive and, to a degree, mutilating, but I, for one, am perfectly willing to resort to this procedure to see if surgery cannot accomplish more in these advanced lesions than we have been able to accomplish with roentgen therapy to date.

Vol. 67, No. 3

ROENTGENOGRAPHIC CEPHALOPELVIMETRY*

By FRED O. COE, M.D.
WASHINGTON, D.C.

CEPHALOPELVIMETRY is an important adjunct of obstetrics and the demand for accurate and dependable measurements is ever increasing. There is and has been too much inertia among radiologists to learn and use a method which is adequate. Unless radiologists are well versed in the use of some adequate method of pelvimetry they will be relegated to the position of technicians who take films and the obstetricians will make all interpretations. An anteroposterior and a lateral film of the abdomen is *not* an adequate examination of the pregnant female. Such slipshod methods are not only inadequate but dangerous since the reports based upon them often give the obstetrician a false sense of security with disastrous results.

A method of cephalopelvimetry is here presented which the writer has used for many years and which it is believed offers advantages not present in methods hitherto described. All of the commonly used methods lack some essential element which this method includes. Without altering the routine technique, cephalopelvimetry is accomplished regardless of the presentation; the normal or abnormal position of the placenta is ascertained and also the size and condition of the fetus.

The method is based upon four films designated as follows: (1) anteroposterior standing; (2) lateral standing; (3) inlet; (4) outlet.

POSITIONS

(1) The anteroposterior standing film is made with the patient standing without shoes. The 14 by 17 inch film is so positioned that the ischial tuberosities are at the bottom of the film. The tube is centered on the center of the film. Target-film distance 100 cm. (Fig. 1, Case 1).

(2) The lateral standing film is also made with the patient standing without shoes in the exact lateral position. The film is so positioned that the ischial tuberosities will show completely and accurately superimposed at the bottom of the film. The tube is centered on a point half way between the symphysis pubis and the top of the sacrum. This is at the upper border of the greater trochanter. It will be noted that in this exposure the tube is not focused on the center of the film, but below the center; target-film distance 100 cm. Absolute laterality of the patient is achieved by measuring with calipers from the table top to the mid-gluteal fold and from table top to mid-labial fold and shifting the patient until these measurements are equal.

FIG. 1. Case 1. Anteroposterior standing view. Cephalic presentation.

* From the Radiological Clinic of Drs. Groover, Christie and Merritt, Washington, D. C. Presented at the Fifty-first Annual Meeting, American Roentgen Ray Society, St. Louis, Mo., Sept. 26–29, 1950.

Fig. 2. Case 1. Lateral standing view. Cephalic presentation.

This measurement is recorded. The patient is held in position by the usual pressure band. The tube and Bucky diaphragm are locked and the exposure made. The patient is removed. A lead grid with perforations at 1 cm. intervals is then hung in the exact sagittal plane as previously measured with the calipers and a second flash exposure made. Thus the distortion of the centimeter markings on the lead grid will be the same as all objects in the sagittal plane (Fig. 2 and 3, Case 1).

(3) The inlet film—Thoms' method.[2] The patient sits on the table top with a back rest (Fig. 4). The latter is adjusted so that the plane of the pelvic inlet is parallel to the film. This is not absolutely necessary but is a useful refinement in technique. The level of the top of the first sacral segment is located by outlining the rhomboid of Michaelis posteriorly. This is marked with a strip of adhesive tape. The distance from the superior aspect of the symphysis pubis to the film is measured with calipers. It must be remembered that the film to table-top distance is 3 cm. The film is exposed. The patient is removed. Then a lead grid with perforations 1 cm. apart is placed over the exposed film, the front being at the height previously measured from the symphysis pubis to the film, and the back of the grid at the height from the top of the first sacral segment to the

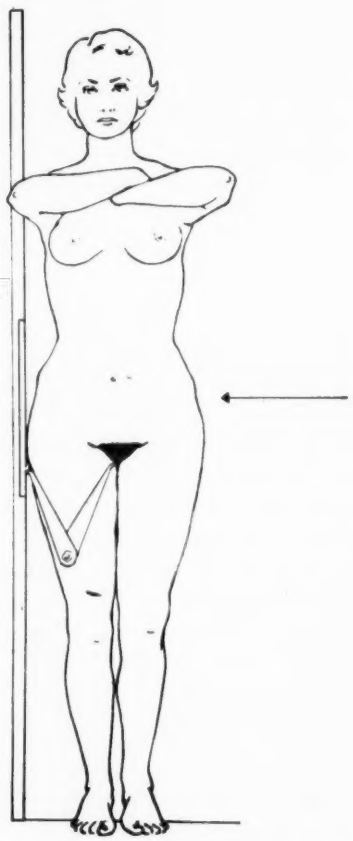

Fig. 3. Lateral standing position.

film. The grid thus is in the plane of the superior strait. The second exposure is made with the grid in place. This superimposes the dots on the image on the film. As the dots are the same distance from the film as the plane of the superior strait they are both distorted equally. Target-film distance 100 cm. (Fig. 5, Case 1).

(4) Outlet film. The Lysholm grid is used. The patient sits on the 10 by 12 inch film, placed on a chair-height stool, with the legs as widely abducted as possible and the torso flexed until the symphysis pubis comes as near the film as possible. Thus the inferior rami of the pubes and ischai

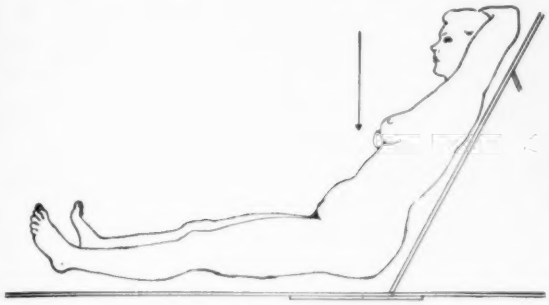

FIG. 4. Thoms' method for inlet roentgenogram. True conjugate parallel to film.

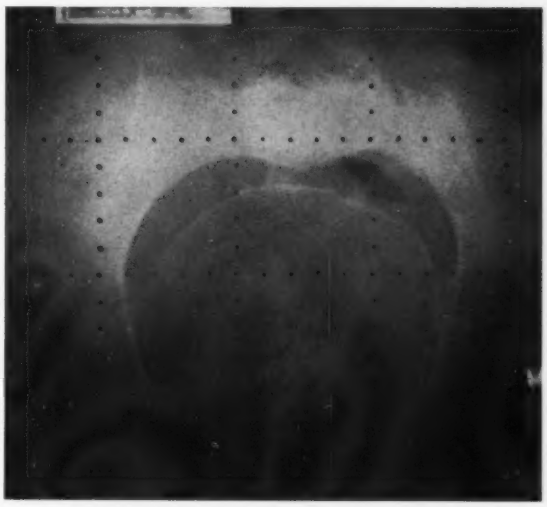

FIG. 5. Case 1. Inlet roentgenogram, Thoms' method. Cephalic presentation.

FIG. 6*A*. Outlet roentgenogram; method of Chassard and Lapine.
FIG. 6*B*. Case 1. Method of Chassard and Lapine for outlet roentgenogram.

are parallel to the film and almost in contact with it. The central ray passes through the mid-portion of the sacrum posteriorly. Target-film distance 150 cm. (Fig. 6, *A* and *B*, Case 1).

DEFINITIONS

Indirect Measurement: This refers to caliper measurement on the film, corrected by reference to the dots on the film. These dots represent a centimeter at the plane of the lead grid distorted by the distance of the film from the plane of the grid.

Direct Measurement: This is the measurement taken directly on the film by a centimeter rule.

INTERPRETATION OF ROENTGENOGRAMS

(1) *Anteroposterior Standing Film.* In this projection the size, position and general condition of the fetus can be determined. It also demonstrates maturity of the fetus, any abnormality of its bony structure, and the relationship of the fetal skull to the maternal skeletal structures. The position of the placenta is usually demonstrated. In cephalic presentation the skull is normally in the midline. If it is displaced laterally there may be a portion of the placenta or a soft tissue tumor causing the displacement. In conjunction with the lateral standing film the cause of the displacement can be ascertained. It is evident that the same forces which cause the fetus to remain stationary act the same during the anteroposterior and lateral standing positions. This is in marked contrast to the action of gravity with the patient supine or in the lateral recumbent position.

(2) *Lateral Standing Film.* The following information is obtained:

1. The true conjugate or anteroposterior diameter of the inlet, as measured indirectly from the posterior surface of the top of the symphysis pubis to the promontory of the sacrum.

2. The anteroposterior diameter of the mid-pelvis as measured indirectly from the posterior aspect of the mid-portion of the symphysis pubis to the mid-point of the anterior surface of the sacrum.

3. The posterior sagittal diameter as measured from the lowest point of the superimposed tuberosities of the ischia to the last segment of the sacrum.

4. The distance of the ischial spines from the plane of the superior strait. By subtracting this distance from the recorded distance of the superior strait from the film, the distance of the spines from the film as shown in Thoms' position is determined.

5. The measurement of that diameter of the skull which is in profile.

6. The position of the skull in relation to the symphysis pubis and promontory of the sacrum. If this relationship is abnormal, that is, displaced either forward or backward, a placental segment is usually found (Fig. 2, Case 1).

7. In case of breech presentation the distance of the middle of the fetal skull from the maternal posterior surface can be measured (*D*, Fig. 7, Case 11). Knowing this distance the size of the skull as seen on the anteroposterior film can be measured as follows: The diameters of the skull on the anteroposterior film are measured in centimeters on the film (Fig. 8, Case 11). Then by reference to the scale the exact diameters are found. The true diameter is shown by the point at which the string, dropped to the indicated centimeter diameter on the abscissa, crosses the horizontal ruling at the above-determined skull-film distance. If the skull is in the maternal sagittal plane, as determined from the anteroposterior film, the diameter which is in profile can be measured indirectly.

8. The shape of the inner surface of the sacrum. This is described as to whether it is normal, flat, etc.

(3) *Inlet Film:* The following data are obtained from the inlet film:

1. The transverse diameter of the inlet. This is the greatest transverse diameter taken just posterior to the middle of the true conjugate.

2. Oblique diameters of the inlet. These are measured indirectly from the sacroiliac joints to the middle of the opposite superior rami of the pubes. The oblique

diameter is designated from the sacroiliac joint involved.

3. The interspinous diameter of the mid-pelvis. The distance between the spines is measured with a centimeter rule and, knowing the distance of the spines from the film (lateral standing film), by reference to the scale the corrected measurement is derived.

4. Fetal skull. If the skull is engaged and lies in the plane of the superior strait both occipitofrontal and biparietal measurements can be made indirectly.

5. Excessive protrusion of the sacral promontory can be seen in this view.

(4) *Outlet Film:* In this film the entire pubic arch can be seen in its true relationship and with very little distortion, due to the long target-film distance and the proximity of the arch to the film. All measurements are direct. A line is drawn between the extreme limits of the ischial promontories and a second line drawn parallel to the first and 1 cm. nearer to the symphysis pubis. This second line is the intertuberous distance and is referred to hereafter as *AB*.

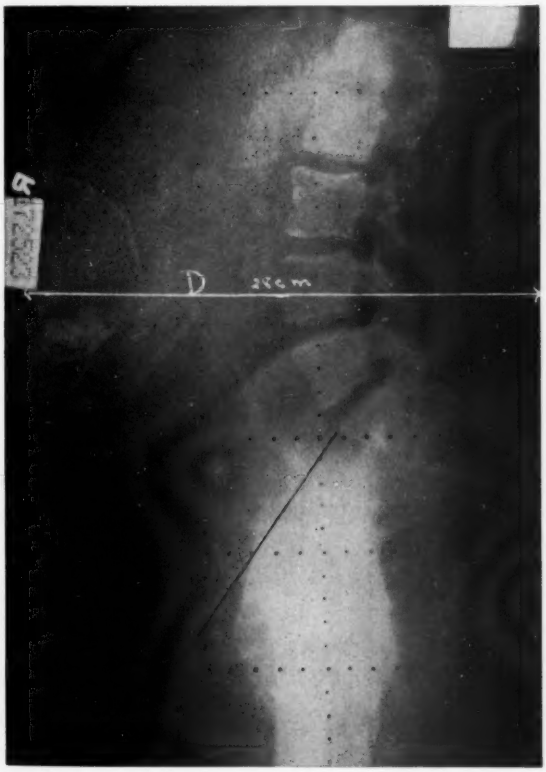

Fig. 7. Case II. Lateral view with the patient in the standing position. Breech presentation. Distance from mid-skull to back of patient can be measured.

Fig. 8. Case II. Anteroposterior view with the patient in the standing position. Breech presentation. Fronto-occipital diameter of skull can be measured

From the middle of *AB* a line is drawn to the lower margin of the symphysis pubis. This is the anterior sagittal measurement of the outlet. A third line parallel to *AB* is drawn at the mid-point of the anterior sagittal distance. This is referred to as *CD*.

The percentage relationship of *CD* to *AB* determines the shape of the arch. In the normal curved arch *CD* would be 70 per cent of *AB* while in a straight-sided arch it would be 50 per cent of *AB*. Lines are drawn from the lower margin of the symphysis pubis to the inner margins of both ischial tuberosities. The angle between these lines is the subpubic angle. It averages 83 degrees in the normal arch (Fig. 6*B*, Case 1).

(5) *Description of the Scales:* The scale provides a simplified method to determine quickly the size of the object from the size

of the image on the film. A graph paper with centimeter divisions forms the base. A string is fastened above, its length from the point of attachment to the base of the graph being equal to the target-film distance, *i.e.*, 100 cm. Thus, the base of the graph, the abscissa, represents the size of the image as measured on the film. The

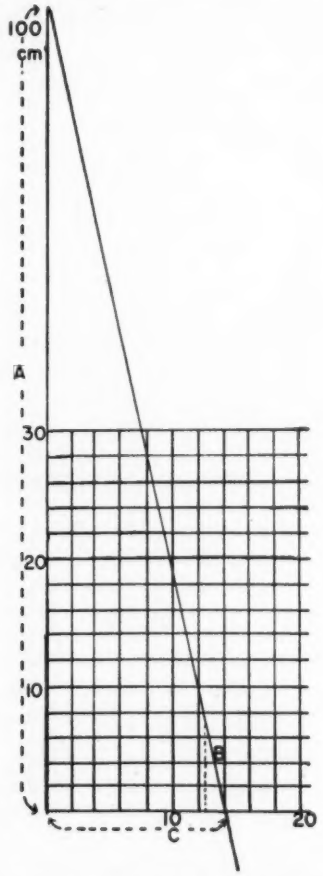

Fig. 9. Scale *A*, target film distance; *B*, distance of object above film; *C*, size of image on film.

vertical markings of the graph represent the object-film distance. The string is centered on the base line at the exact measurement of the image on the film, and the size of the object is determined by noting the point where the string intersects the horizontal line at the object-film distance (Fig. 9).

If desired, a graph can be made for use instead of the scale described above (Fig. 10). This is constructed by the following formula: target-film distance:target-object distance::size of the object on film = actual size of the object. This can be computed for each centimeter on the horizontal scale for a target-object distance of 70 or 80 centimeters and the line extended. This graph is accurate but requires more time to interpret than the scale with string.

APPARATUS

The only apparatus required in addition to the conventional roentgenographic table and tube stand is as follows:

1. A pair of calipers.
2. A scale.
3. A board to assist in positioning the patient in the semi-reclining posture.
4. An upright Bucky diaphragm.
5. Perforated lead plate.

The mimeographed chart used in reporting cases to the referring obstetrician is shown in Figure 11. This is modified from that used by Snow. It is most satisfactory, giving the referring doctor a complete evaluation of the findings.

Following the method of Mengert,[1] we evaluate the dimensions of the inlet, the mid-pelvis, and the dimensions of the fetal skull. That is, the index for the inlet is the product of the true conjugate by the transverse. For the mid-pelvis the index is the product of the anteroposterior by the interspinuous. The index for the skull is the product of the fronto-occipital by the biparietal. Our average index for the inlet is 145.7; that which Mengert considers 100 per cent is 145. For the mid-pelvis our average index is 126; that of Mengert is 125. The average index for the fetal skull at term, excluding hydrocephalus, is 105.

A study of reports of deliveries of 200 cases examined indicates that when the index of the skull exceeds 80 per cent of the inlet or 85 per cent of the mid-pelvis, safe pelvic delivery is very unlikely. When the index of the skull is 75 per cent, or less, than the index of the inlet or mid-pelvis, pelvic delivery is safe unless there are complications such as inadequate outlet, placenta previa, or abnormal presentation.

Our records of cases delivered over a

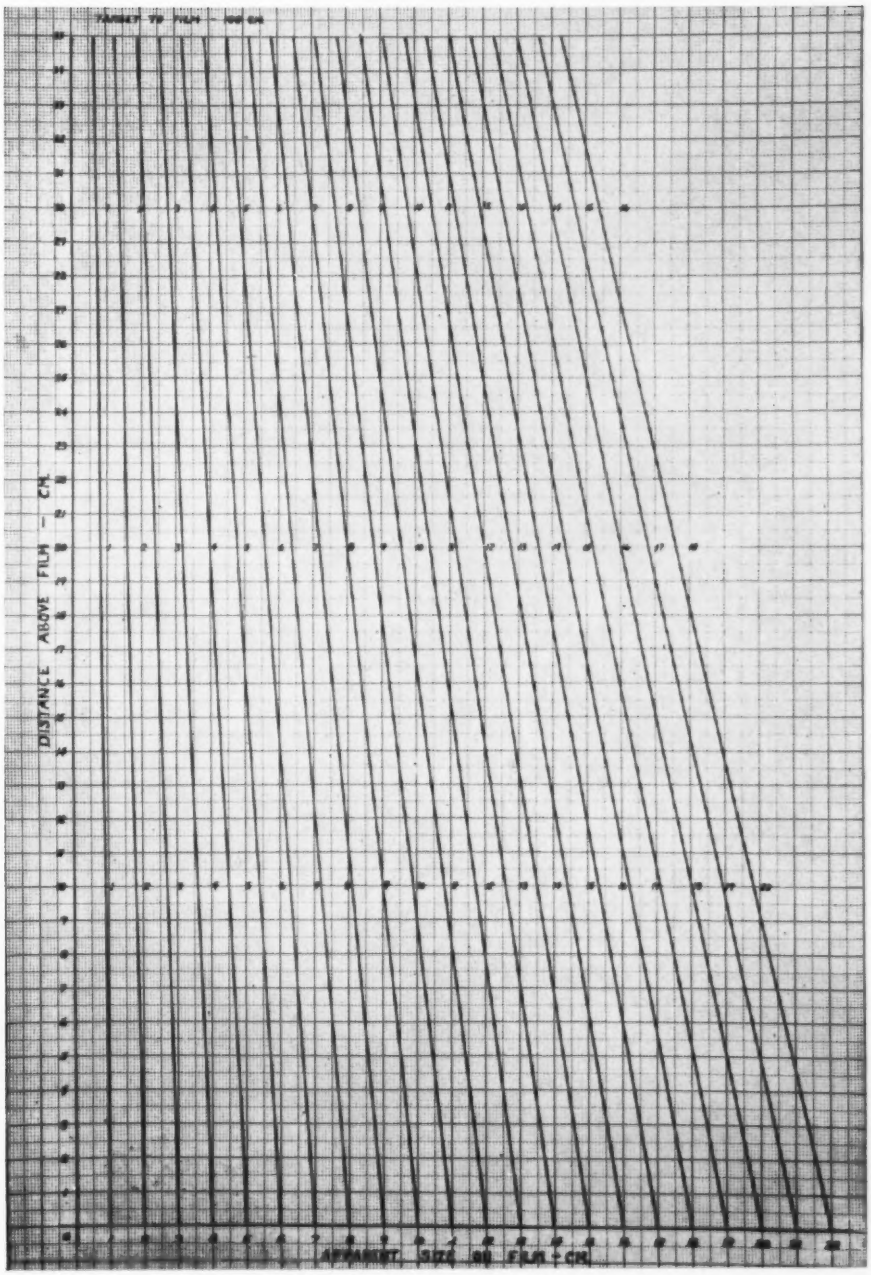

Fig. 10. Chart of scale calculated for each centimeter from 0 to 22 cm. on base and from base to 35 cm. above base.

period of years confirm our opinion that the method of cephalopelvimetry here described is accurate and adequate. Measurements of the skull made postpartum have corresponded with a high degree of accuracy to those made by cephalopelvimetry. It is true that final judgment concerning delivery in a case of pregnancy is not to be based solely upon mathematical formulae, but cephalopelvimetry, when accurately done and properly interpreted, is a great step forward in the prevention of birth injuries and reduction in maternal morbidity and mortality.

1835 Eye St., N. W.
Washington 6, D.C.

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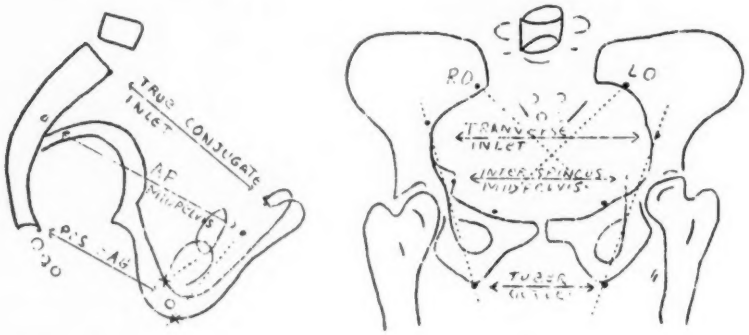
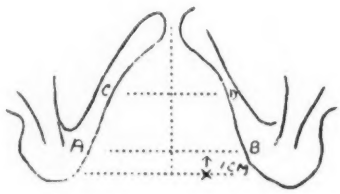


PELVIC INLET	
True conjugate	12.50
Transverse	12.25
Rt. oblique	12.50
Lt. oblique	12.50
Shape	anthropoid
MID-PELVIS	
AP	13.50
Interspinous	11.20
Sacrum	flat sacrum
OUTLET	
Post. sagittal	9.00
Inter-tuberosity (A-B)	10.00
Mid-transverse (C-D)	6.00
Lateral walls	convex medially
Sub-pubic notch	82°
SOFT TISSUES	
Placenta fundal	
Fluid	



FETUS	
Presentation	L. O. A.
Skull diameters:	F.O.-11.0 B.P.-9.5
Estimated age	
Abnormalities	

COMMENTS: Skull is at ischial spines with patient standing. There is no cephalopelvic disproportion, but flat sacrum and abnormal subpubic arch may delay passage. foc.

FIG. 11. Mimeographed chart used in reporting Case 1 to obstetrician.

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2. THOMS, H. Fetal cephalometry in utero; method for estimating occipitofrontal diameter, and statistical study of cephalic measurements in 149 unmolded heads. *J.A.M.A.*, 1930, *95*, 21–24.

DISCUSSION

DR. PAUL C. SWENSON, Philadelphia, Pennsylvania. Dr. Coe's presentation is important not so much from the standpoint of the description of his method of cephalopelvimetry as it is to emphasize that this procedure has a real place in obstetric management and that it is being used by all the large medical centers. We do not mean to imply that obstetrics cannot be practiced without it, but if and when it is available, it does represent a diagnostic technique which makes obstetrics easier and gives the obstetrician real aid in his decisions.

Dr. Coe has developed a technique which appears to be very efficient and practical. It is entirely adequate. As he himself has said, it is not entirely original. He has added to some of the older ideas those of his own which make his procedure a little more adaptable. There is no great innovation in what he has shown us and it isn't likely that it will prompt any of us to make any sweeping changes in our own techniques as long as our own established methods are getting the proper results.

I am pleased to see that Dr. Coe emphasizes the importance of the mid-pelvis and the outlet. So often emphasis is laid on the inlet only, and the feeling in general has been that if the head

engages everything will be satisfactory. This is by no means the rule. While I do not particularly approve indices, yet they do give us some sort of a working basis and serve to warn the obstetrician of trouble if and when they are out of line. I have been able to get the same impression without measurement in most cases by using carefully made stereoscopic films.

I heartily indorse the statement made by Dr. Coe that we cannot reduce the various factors of interpretation to a mathematical exactitude and herein lies the crux of the problem. There are so many extra-osseous factors that might be the cause for dystocia in both the adequate and borderline cases that a trial of labor must almost always be made. Even an adequate pelvis may be found in cases where there may be plenty of indication for cesarean section. It must always be remembered that pelvimetry is just one factor in the problem of obstetric management.

It has been suggested that when a certain index is small and there is a reason to predict trouble we might urge section for any questionable case, particularly now that surgery has reached such a high level of proficiency, and also since we have the antibiotics to aid us. However, when this subject is broached to the usual conservative obstetrician, he immediately emphasizes that the vaginal route is still the best for delivery whenever it can be safely accomplished.

Dr. Coe has said nothing about the use of progress films during labor. I should like to know whether he shares our feeling that this is also an important adjunct to the rest of the roentgen management.

I would also like to say a word about the measurement of the head in breech presentation. It is our feeling that even though accurate measurement of the fetal head can be made, that we can dare to go little further than to describe the fetal head in terms of *average*, *large* or *small* although Dr. Coe may be able to do so. In the first place, Dr. Donaldson has shown, in a recent report, how difficult it is to estimate the weight from this feature alone. Secondly, accurate measurements without a knowledge of the other unknowns, namely uterine forces and moldability of the head, are relatively useless. Clinical correlation is always necessary particularly in the borderline case.

I have enjoyed listening to Dr. Coe's presentation. I think he has shown us a very practical procedure. When careful clinical correlation is carried out, his procedure should be of great value.

Dr. Coe (closing). I have nothing more to say other than that the progress film is of considerable consequence. It is easily done. The exact routine has been carried out many times with the patient in labor. The patient seems to appreciate being able to get off her back and stand on her feet. Unless the patient is under an anesthetic the examination is easily made during labor. We get the films in between the labor pains, and have very little difficulty.

I have been urged to state in my report that cesarean section is indicated. I refuse. We can hoist the hurricane signal, and if the obstetrician does not heed the report, this is not in our province.

DEPTH DOSE INVESTIGATION FOR PERFORATED GRID THERAPY AT 200 KILOVOLTS

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and

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THERE is now a revival of interest, both in this country and abroad, in radiation therapy through a multiperforated protective screen or grid. Preliminary reports seem to indicate, in certain selected cases, better results than heretofore obtainable with conventional modes of therapy. In July, 1950, a study of the clinical results with grid therapy was begun at Montefiore Hospital by Dr. J. R. Freid, Attending Radiotherapist, in charge, Department of Radiotherapy.

The depth dose investigation was undertaken in order to find out what dose the patient was receiving at the surface, at the tumor, and at other depths, for there were no published data at this time.

REVIEW OF LITERATURE

It has been reported by previous investigators that a greater dose can be delivered to a tumor with less radiation damage to the skin when a grid is used[8,11,13] or that the same dose delivered to a tumor with the grid is more effective.[8,11]

Liberson[11] published his findings in 1933 after many years of careful work with what he called a multiperforated screen. He reported the following results: Round or oval perforations of diameters varying from 2 to 8 mm. were preferable to other shapes, with the openings not more than one-half the total area. The depth dose in a water phantom was 50 per cent of the depth dose without the grid if 50 per cent of the field was exposed. A more uniform field at a depth could be obtained while the skin at the surface was protected by keeping the grid fixed and changing the position of the tube in a horizontal plane parallel to the treated area.

He showed photographs of the field in horizontal and vertical planes.

Liberson investigated the biological effect and found a greater differential action between a depth and the surface with the grid than without it.

After the appearance of Liberson's article, Köhler wrote a letter to *Radiology* in which he stated that he had described the same method in 1909 in European journals.[9,10] Köhler may therefore be considered the first to publish work on the perforated grid. Liberson, in answer to Köhler, however, stated that prior to his own publication he had no knowledge of Köhler's work.

Dr. Anna Goldfeder, in a personal communication to us, stated that in 1938 at the University of Warsaw she demonstrated the necessity for using larger doses for the destruction of animal tumors than were being used and that she could safely administer these doses because the portal was small. She stated that Grynkraut became interested in the method and treated patients with multiple small portals as described in his article.[16]

Goldfeder,[3] in writing about the direct and indirect effects of radiation, mentions the use of grids made of lead rubber consisting of "alternating transparent and opaque squares 1 cm. and 2 cm." In another article, she states that 24,000 r in air is the dose necessary for the destruction of a certain strain of tumor grown in rats.[2]

Grynkraut, in a more recent publica-

* Fellow of the American Cancer Society.

tion,[4] describes the grid he used. It was made of 2 mm. of lead cemented to 1 mm. of aluminum. The apertures were 3 by 3 cm. squares separated by 0.5 cm. of material.

Haring[5] published a paper on the use of the grid, or "Siebstrahlung" as he called it. He thought that the effectiveness of this method of treatment might be due to its inhomogeneity, as in the case of radium implants. Holes 3 mm. in diameter were punched into a lead plate 3 mm. thick. The ratio of open areas to closed areas was 1 to 1. He found the air dose with the grid 50 per cent of the air dose without the grid, and the secondary radiation in a water phantom for a 6 by 8 cm. field at 40 cm. target-skin distance with the grid was 53 per cent of that without the grid. He concluded that there was half as much secondary radiation with the grid as without the grid. He administered 1,650 r, measured in air, to the grid at one time and described the course of the erythema. He came to the conclusion that grid therapy was no better than regular therapy.

Marks revived an interest in grid therapy in this country. He reported a grid technique employed with good results.[13] The grids were made of lead rubber 3 mm. thick with openings varying from 0.25 sq. cm. to 4 sq. cm. in a checkerboard arrangement. He stated the openings were 40 per cent of the total area. The grid was applied in the same position on the skin each time. Patients were given a dose of 600 r, measured in air, three times a week, or 1,200 r daily up to a total air dose of 24,000 r.

In England, Jolles used the "alternating chessboard method" on accessible malignant tumors.[7] The grid he used had 1 cm. squares in a chessboard arrangement. Surface doses were given for the particular set-up in each case. Jolles, like Liberson, treated with the reverse grid, *i.e.*, a grid whose openings correspond to previous covered portions and covered portions to previous openings. Biopsies were made of various portions of the tumor and the covered portions were compared to the directly irradiated portions. He states that the method yielded results which were better than conventional roentgen or radium therapy, and presented a theory for this result.[8]

In an attempt to answer the depth dose question, Loevinger made water phantom measurements, some of the results of which appear in a preliminary paper[12] in which he reports that the depth doses with the grid can be obtained from conventional depth dose tables and that these values are in good agreement with his experimental values if the following steps are used in the calculation:

1. Plot attentuation curve for the primary beam from tables for small fields.
2. Plot "total" regular depth dose curves from tables for the size of field desired. Subtract (1) from (2) to get the portion due to scattered radiation.
3. Use the per cent of opening to total area as the multiplication factor. Multiply the scattering due to the total field by the multiplication factor to obtain the scattering when the grid is used.
4. Add depth dose of primary beam to scattered portion due to grid and obtain the depth dose with grid for open portions.

A comparison of his results with ours will be given later.

EXPERIMENTAL SET-UP

Measurements were made in a masonite presdwood phantom 30 cm. thick. The density of the material was 1.05 gm./cc. Each board had a surface 30 by 30 cm.^{2} and was 0.373 cm. thick. In all measurements at least 15 cm. of material was underneath the ionization chamber. The Victoreen 25 r and 250 r ionization chambers were used in a condenser dosimeter.

Groups of six boards, called the chamber boards, were drilled so that the ionization chamber fitted snugly into them at the center, one group for the 250 r chamber and one for the 25 r chamber. Each group was divided into two parts or sets. The chamber rested in one set and the other set covered the chamber. The surface measure-

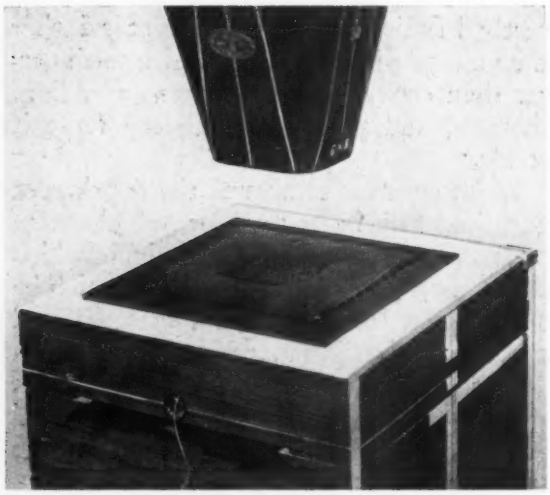

FIG. 1. Photograph of set-up.

ments were made with the chamber half "submerged" in the same manner as surface measurements are made for water.[6] At other depths the chamber was inserted into the chamber boards and removed by means of an attached string so that reinsertion could be made without disturbing the portion of the phantom above the boards.

The roentgen rays were generated by a 200 kv. machine and had a half-value layer of 0.94 mm. Cu. Cones were used to limit the field grossly. Lead rubber cut-outs for each size field limited the field to the desired area.

The positioning of the tube and the grid are very important.

The boards which gave a depth of 5 cm. and 10 cm. were pegged together. On top of the uppermost board in each pegged group, a piece of millimeter graph paper was pasted. Graph paper was also pasted on each set of lower chamber boards. Lines were drawn parallel and perpendicular to the long axis of the ionization chamber crossing each other at a point which corresponded to the center of the air volume of the chamber. To help in the alignment of the centers of the boards, a narrow strip of graph paper was pasted in the middle of one side, and the center line of the board was extended down on this side. The movable table which held the phantom had two lucite plates so arranged as to form two sides of a box. The boards were pushed into the open sides of the box so that they fitted against the lucite plates. The center of one of the lucite plates was etched. When the boards were properly aligned, the center line along the side of the phantom coincided with the center line of the lucite plate. All of these precautions are necessary to insure that an opening in the grid which is placed on the top of the phantom is in proper alignment with the air volume of the chamber.

The lead rubber grid was made with the aid of a template built in our machine shop. The use of a template assures uniformity of holes and spacings. The diameter of each hole was 1.0 cm. and the distance between centers 1.4 cm. The grid was then 40 per cent open and 60 per cent closed. The lead rubber was 4 mm. thick, with a lead equivalent of 1.3 mm., and transmitted less than 1 per cent of the incident roentgen-ray beam under investigation. The dimensions of the grid containing the openings were 20.5 by 20.5 cm. Lines perpendicular to each other were drawn down the center of the grid and cut-off dulled needles used as pointers were inserted into the rubber at the ends of each line. The grid could then be placed on the graph paper so that the center of the grid or any portion of it was directly over the air volume of the chamber.

The depth doses measured were for the center of the field at all depths. In any measurement the following procedure was observed. The particular cone to be used, a 10 by 10 cm. for the smallest fields, was firmly fixed in position. The tube was brought down so that the surface of the cone was parallel to the phantom and centered so that its center was directly above the position of the center of the air volume of the ionization chamber in the chamber board. In the case of the 60 cm. investigation the tube was then raised to make the target-skin distance 60 cm. The grid was aligned with the aid of the pointers on the graph paper so that the desired portion of the grid was above the air volume of the

ionization chamber. The lead rubber cut-out which gave the proper size of field was placed on the top of the grid and centered so that the center lines of the cut-out were aligned with the center lines on the graph paper (see Fig. 1 for set-up).

When the small air volume 250 r ionization chamber was used, it was necessary to take roentgenograms of the position of the chamber in the phantom to insure that it was correctly postioned, directly under the center of a hole for the direct beam and totally under the covered portion for the

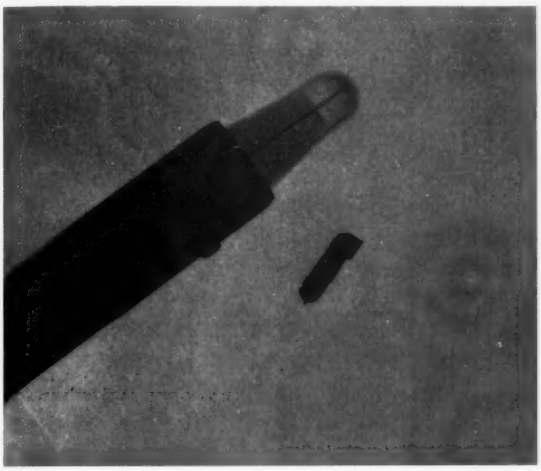

Fig. 2. Roentgenogram of 250 r small air volume ionization chamber.

secondary radiation. A roentgenogram of the chamber itself is shown in Figure 2. The air volume is clearly visible. The diameter is 7 mm. and the volume is approximately 0.2 cu. cm. The presdwood board directly underneath the chamber boards had a U-shaped cut-out which could be removed for the insertion of a film wrapped in black paper. After positioning as above, the ionization chamber with a thin lead marker fixed by scotch tape around it was inserted into the chamber boards at the depth under investigation and a roentgenogram taken. This was developed, and showed how much the grid had to be shifted for correct centering. The needle pointers and graph paper made it possible to shift the grid as little as 0.5 mm. After the grid was shifted, another roentgenogram was

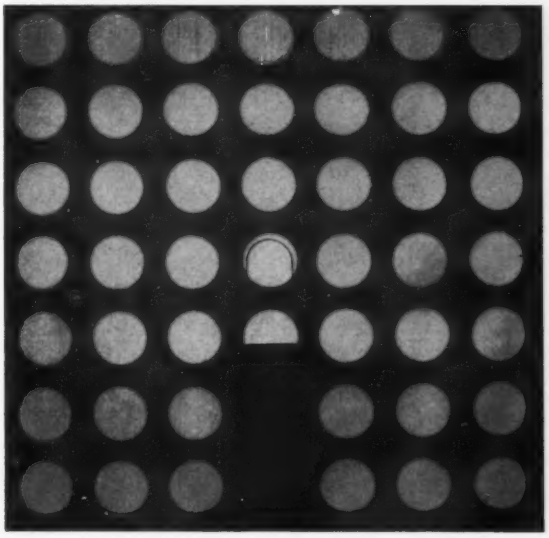

Fig. 3. Roentgenogram showing that ionization chamber is under center of grid opening at a depth of 5 cm.

taken and this was repeated until the ionization chamber was in the desired position. With experience, only one film was necessary. The position where the chamber was under the center of the hole was called the photographic max., and the one where the chamber was under the covered portion was called the photographic min. Figure 3 shows that the air volume of the ionization chamber is under the center of an opening in the grid.

In order to show that the air volume was under the covered portion, the thin lead marker was fastened to the portion of the ionization chamber just below and lateral to the air volume. This lead marker would appear in the field of the hole showing that the air volume was just above and under the covered portion. The picture of the stem shows whether the ionization chamber is centered laterally (see Fig. 4).

The centering was further checked by ionization measurements. The ionization chamber was inserted into the chamber boards with the grid position as determined photographically, and the grid moved a millimeter at a time to determine in which position the grid had to be to give a maximum reading or a minimum reading. This position was the one used for the final

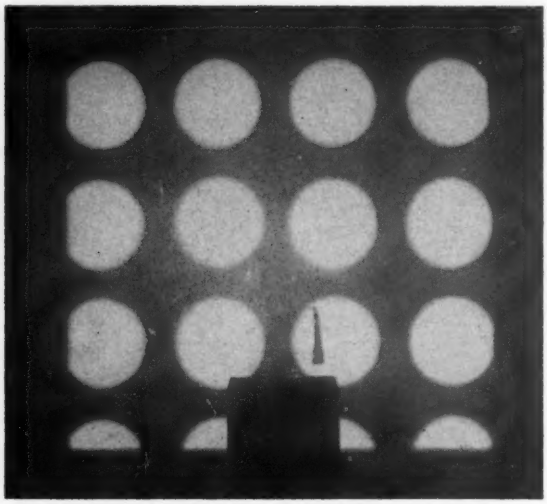

FIG. 4. Roentgenogram showing that ionization chamber is under covered portion at a depth of 10 cm.

measurements. For each depth, the grid and chamber positions were kept fixed and the size of the field varied. The output in air at the required target-skin distance was measured at the beginning and at the end of the experiment and found to remain constant.

When the 25 r chamber was used, a different procedure was adopted. The air space occupies a volume of approximately 2 cc. The diameter of the cross section is 1.1 cm. and the length approximately 2 cm. (see Fig. 5). When the grid is placed over this chamber, it can be exposed to the rays coming through one hole and more than half of another hole and the connecting covered portion between the holes. Thus, the chamber averages the radiation coming through this surface. For surface measurements the grid was placed directly over the chamber with the centers of the holes over the center of the chamber.

In order to find the position of the grid which gave a maximum of transmission of roentgen rays, the grid was shifted a millimeter at a time, first perpendicular to the long axis of the chamber, and then parallel to the long axis. This position was found for each depth and then used as a basis for grid placement, when the apparatus was taken apart and set up again.

In a similar way the position giving the minimum of transmission of roentgen rays was found. For this case the ionization chamber is measuring the roentgen rays coming through the lead rubber between four holes, and the radiation through a portion of each of four holes. In a sense, then, the chamber is averaging the radiation under the grid but in a different portion than the setting for maximum transmission.

For each case, the chamber, of course, is measuring, in addition to the primary radiation, secondary radiation created in the surrounding volume of phantom material.

The values in the table for the 25 r chamber were computed by averaging the reading obtained with maximum and minimum transmission.

RESULTS

Depth dose measurements were made for a 10 by 10 sq. cm. field at 60 cm. target-skin distance, using the presdwood phantom, and the results were compared with those of Quimby[15] calculated to 60 cm. target-skin distance by the inverse square law, and with those of Bush.[1] Our depth dose measurements agreed, within experimental error, with the others.

It might be well to devote a paragraph to a discussion of what is meant by depth

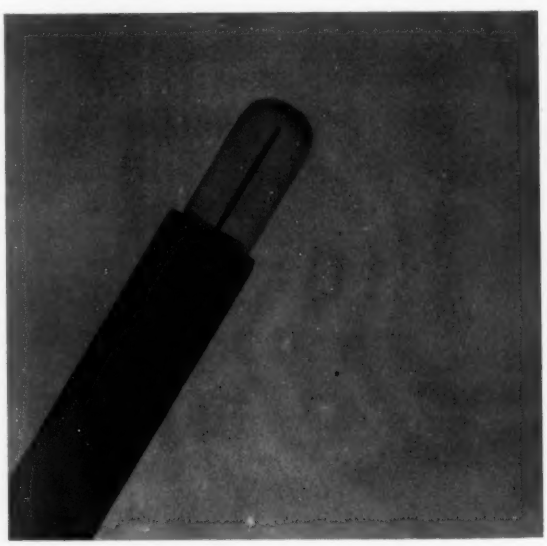

FIG. 5. Roentgenogram of 25 r "large" air volume chamber.

dose with a perforated grid. There are two distinct portions on the surface and in the underlying tissue. One portion receives the direct radiation through the opening plus the secondary radiation produced in the volume of tissue; the other portion receives only the secondary radiation plus about 1 per cent of the direct radiation transmitted through the lead rubber. The depth doses are therefore different in each portion

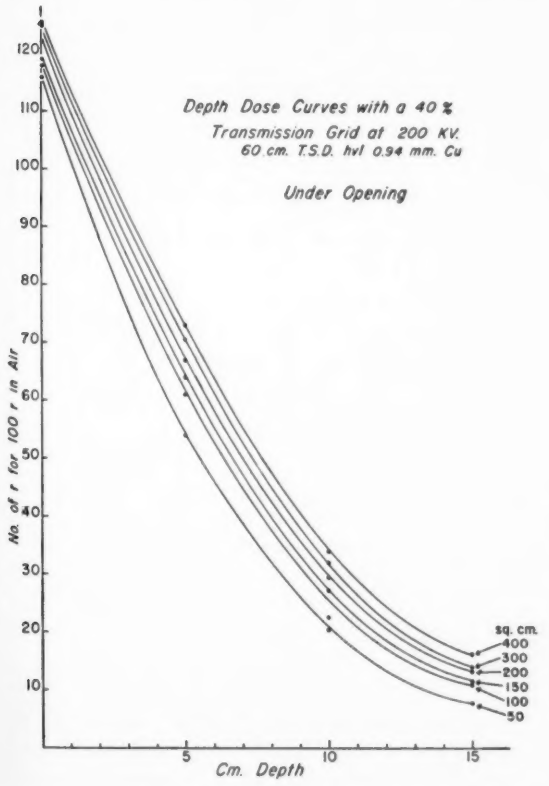

Fig. 6. Depth dose curves for a target-skin distance of 60 cm., half-value layer 0.94 mm. Cu, for portion under opening in grid using 250 r chamber.

at any level. When an average of these two is made, one must keep clearly in mind that there really is no physical average, but only a calculated one. The portions under the holes receive more at all levels than the portions underneath the closures. The difference decreases as the depth increases where the contribution of the secondary is a greater fraction of the total radiation.

The results for each distance and specific

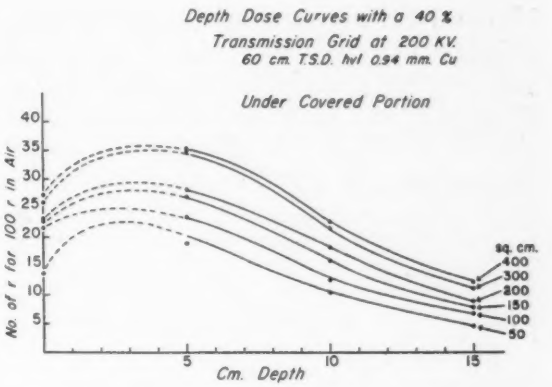

Fig. 7. Depth dose curves for a target-skin distance of 60 cm., half-value layer 0.94 mm. Cu, for portion under covered part of grid using 250 r chamber.

grid could be repeated after the set up was "broken down" and reset, as is necessary in a busy radiotherapy department when the machines can be used only after patients are treated.

Curves based on data obtained with the 250 r chamber for a target-skin distance of 60 cm., half-value layer 0.94 mm. Cu are given in Figures 6, 7 and 8 for the open portion, the closed portion and the average respectively. The ordinate is number of r for 100 r in air, and the abscissa is depth in the phantom in centimeters. The average

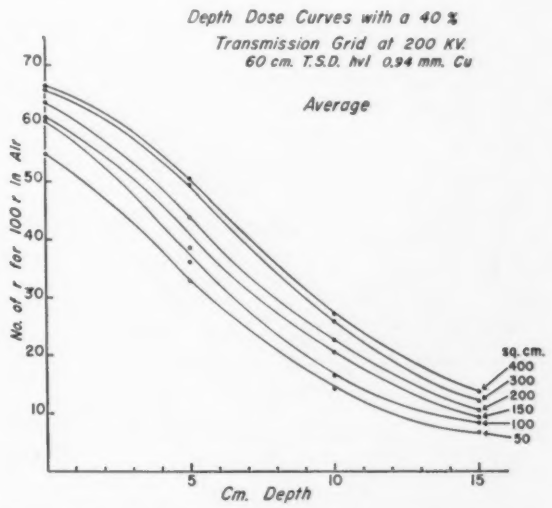

Fig. 8. Depth dose curves for a target-skin distance of 60 cm., half-value layer 0.94 mm. Cu, for the weighted average using 250 r chamber

is obtained by weighting the covered values 0.6 and the open values 0.4. Measurements were made at the surface and at depths of 5 cm., 10 cm. and 15 cm. In plotting the curves for the closed portion, from the surface to a 5 cm. depth the following method was used: These sections of the curves are indicated by broken lines. Curves were drawn for the secondary radiation according to Loevinger[12] from tables by Bush.[1] Since our data varied less at a depth of 5 cm. than at the surface from the values on the "theoretical" curve, the 5 cm. depth was used as the starting point for calculations. The ratios were found between the values at 5 cm. and 4 cm. between 4 cm. and 3 cm. up to 1 cm. from the "theoretical" curve. The 5 cm. data found experimentally was divided by the 5/4 ratio to find the point for a depth of 4 cm., and in a similar fashion the other points were found up to a depth of 1 cm. The surface value is the one found experimentally.

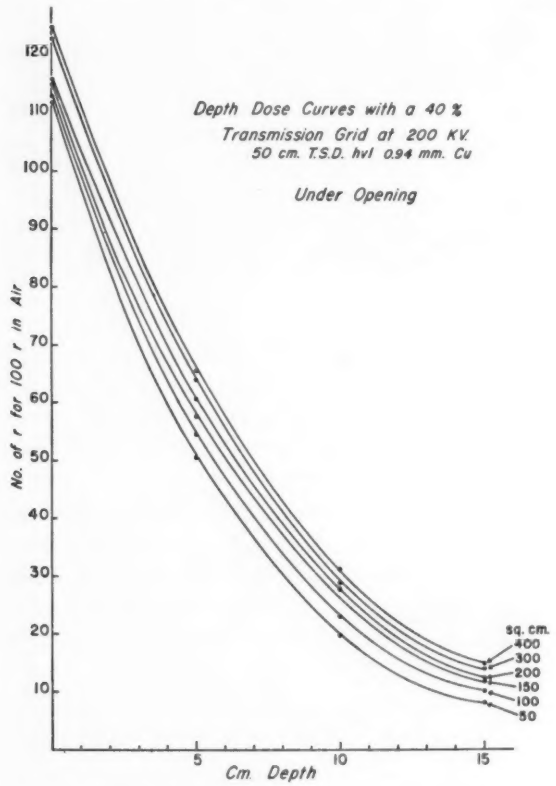

FIG. 9. Depth dose curves for a target-skin distance of 50 cm., half-value layer 0.94 mm. Cu, for portion under opening in grid using 250 r chamber.

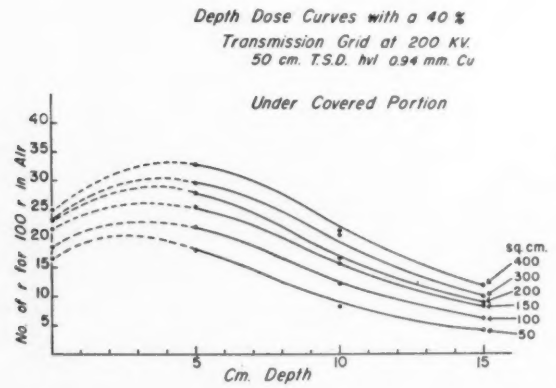

FIG. 10. Depth dose curves for a target-skin distance of 50 cm., half-value layer 0.94 mm. Cu, for portion under covered part of grid using 250 r chamber.

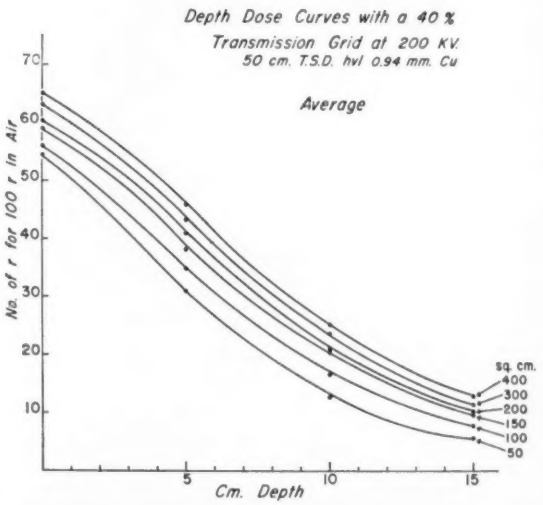

FIG. 11. Depth dose curves for a target-skin distance of 50 cm., half-value layer 0.94 mm. Cu, for the weighted average using 250 r chamber.

Curves for a target-skin distance of 50 cm. for similar conditions are given in Figures 9, 10 and 11. (The distance is 51 cm. because the thickness of the grid and the field cut-out must be added to the cone distance.)

The depth doses at 50 cm. target-skin distance were calculated from those at 60 cm. target-skin distance by the inverse square law for the open and covered portions, and these were in good agreement with the measured values for the 50 cm. target-skin distance. Thus, if the depth

doses at one distance are known, the depth doses under either open or closed portions may be calculated from them.

Table I gives the depth doses in centimeter steps for the open portion, the closed portions and the average for 60 cm. target-skin distance. Similarly, Table II gives the depth doses for 50 cm. target-skin distance.

The figures in Tables I and II are taken from the curves. Table VI is calculated us-

TABLE I

TABLE OF DEPTH DOSES WITH GRID FOR 100 r MEASURED IN AIR FOR DIFFERENT SIZES OF FIELDS

(a) Under Opening (b) Under Covered Portion (c) Average
T.S.D. 60 cm., h.v.l. 0.94 mm. Cu

Depth in cm.	Area of Field in Square Centimeters					
	50	100	150	200	300	400
	(a) Under Opening					
0	116	118	119.5	123.5	124.5	125.0
1	101.5	105.3	107.2	110.0	112.0	114.0
2	88.0	93.5	95.5	98.5	101.0	102.8
3	75.5	82.3	84.8	87.5	90.3	92.5
4	64.0	71.5	74.3	77.2	80.0	82.5
5	54.5	61.7	64.5	67.3	70.5	73.0
6	46.2	52.8	55.3	58.3	61.3	63.8
7	38.8	44.8	47.2	50.0	52.5	55.3
8	32.0	37.5	39.8	42.5	45.0	47.5
9	26.2	31.3	33.2	35.8	38.0	40.5
10	21.0	25.5	27.2	29.7	31.7	34.3
15	7.8	10.8	11.8	13.3	14.0	16.0
	(b) Under Covered Portion					
0	13.5	21.5	22.5	23.0	26.0	27.3
1	20.0	23.8	25.7	26.8	31.0	32.3
2	22.2	24.8	27.5	28.8	33.5	34.5
3	22.5	25.0	28.0	29.5	34.8	35.5
4	21.8	24.3	27.8	29.2	35.0	35.7
5	20.0	23.5	27.0	28.2	34.3	35.2
6	18.3	21.8	25.2	26.7	33.0	34.0
7	16.2	19.7	23.0	25.0	30.7	32.0
8	14.0	17.5	21.0	22.8	28.0	29.3
9	12.2	15.0	18.5	20.5	25.0	26.0
10	10.5	13.0	16.0	18.2	21.3	22.7
15	4.5	6.7	8.0	9.0	11.0	12.3
	(c) Average					
0	54.5	60.3	61.0	63.5	65.5	66.5
1	51.3	56.8	58.0	60.5	63.5	64.5
2	47.3	52.7	54.5	57.2	61.0	62.0
3	43.0	48.0	50.5	53.3	57.5	58.7
4	38.2	42.5	46.0	49.0	53.5	54.7
5	32.7	37.5	40.8	43.8	49.0	50.3
6	28.5	32.3	35.7	38.5	44.0	45.3
7	24.5	27.7	31.3	33.8	39.0	40.5
8	21.0	23.7	27.5	29.7	34.3	35.8
9	17.7	20.2	24.0	26.0	29.8	31.5
10	14.7	16.8	20.7	22.7	25.8	27.5
15	6.7	8.7	9.5	10.7	12.5	14.0

TABLE II

TABLE OF DEPTH DOSE WITH GRID FOR 100 r MEASURED IN AIR FOR DIFFERENT SIZES OF FIELDS

(a) Under Opening (b) Under Covered Portion (c) Average
T.S.D. 50 cm., h.v.l. 0.94 mm. Cu

Depth in cm.	Area of Field in Square Centimeters					
	50	100	150	200	300	400
	(a) Under Opening					
0	112	113	115	116	123	125
1	97.3	99.5	101.3	103.8	109.5	111.5
2	83.0	86.3	88.2	92.0	96.5	98.7
3	70.3	74.3	76.8	80.5	84.3	86.5
4	60.0	64.0	67.0	70.0	73.5	75.5
5	51.0	55.0	58.0	60.8	64.3	66.5
6	43.5	47.3	50.7	53.0	55.8	57.8
7	36.5	40.3	43.7	45.5	48.2	50.0
8	30.3	34.0	37.3	39.2	41.3	43.0
9	24.8	28.3	31.5	33.0	35.0	36.7
10	20.0	23.2	26.2	27.7	29.3	31.0
15	8.0	10.2	11.6	12.5	13.8	15.0
	(b) Under Covered Portion					
0	16.5	18.5	21.5	23.0	23.3	25.0
1	19.0	21.0	23.8	25.5	26.5	28.2
2	20.3	22.3	25.3	27.5	28.7	30.7
3	20.5	22.8	26.0	28.7	30.0	32.5
4	19.5	22.7	25.8	29.0	30.3	33.0
5	18.2	22.0	25.2	27.7	29.5	32.7
6	16.5	20.5	24.0	26.3	28.5	31.5
7	14.5	18.7	22.2	24.5	26.7	30.0
8	12.5	16.5	20.0	22.0	24.5	27.5
9	10.6	14.5	17.7	19.3	22.0	25.0
10	9.0	12.5	15.7	17.0	19.3	22.0
15	4.0	6.0	8.0	8.8	10.0	11.8
	(c) Average					
0	54.3	56.0	59.0	60.3	63.0	65.0
1	50.3	52.5	55.8	57.5	60.0	62.0
2	45.8	48.5	52.5	54.2	56.5	58.8
3	41.0	44.3	48.5	50.5	52.7	55.0
4	36.0	39.7	44.0	46.3	48.5	50.8
5	31.0	35.0	39.0	41.3	43.8	46.2
6	26.7	30.7	34.5	36.8	39.0	41.3
7	23.0	26.8	30.3	32.5	34.5	36.8
8	19.3	23.3	26.7	28.5	30.5	32.5
9	16.2	20.0	23.5	24.7	27.0	28.7
10	13.3	17.2	20.2	21.5	23.5	25.2
15	5.5	7.7	9.4	10.4	11.5	13.0

TABLE III

COMPARISON OF DEPTH DOSES OBTAINED WITH 25 r "AVERAGING" CHAMBER AND AVERAGE OBTAINED WITH 250 r CHAMBER

60 cm. T.S.D., 0.94 mm. Cu h.v.l.
Area of Field in Square Centimeters

Depth in cm.	25		50		100		150		200		300		400	
	Chambers		Chambers		Chambers		Chambers		Chambers		Chambers		Chambers	
	25 r	250 r	25 r	250 r	25 r	250 r	25 r	250 r	25 r	250 r	25 r	250 r	25 r	250 r
0	51.0	52.4	55.0	54.7	58.2	60.3	60.4	61.1	61.7	63.6	62.8	65.7	64.3	66.3
5	26.6	25.9	31.4	32.8	36.0	38.6	39.6	36.4	41.4	43.8	44.8	49.4	46.0	50.4
10	10.9	10.5	13.8	14.3	16.8	16.6	19.5	20.5	21.3	22.7	23.5	25.8	24.9	27.2
15	4.6	4.2	5.9	6.8	8.0	8.5	9.4	9.4	10.4	10.6	11.7	12.2	13.0	13.8

ing these results. The values in the other tables are derived directly from experimental data.

In Table III the depth doses obtained with the 25 r chamber are compared with those obtained with the 250 r chamber. The 25 r chamber is used as an averaging chamber. The value compared is that found by averaging the reading in position of maximum radiation with that in the position of minimum radiation. The weighted average is the one used for the 250 r chamber. The results are in good agreement with the exception of a few individual readings up to a field area of 200 sq. cm. For 200, 300 and 400 sq. cm. fields the weighted averages of the 250 r, small air volume chamber are consistently higher than the average obtained with the 25 r large air volume chamber, the percentage difference varying from 2 to 10 per cent. The average of this percentage difference is 6 per cent. It is surprising that the two different methods yield results which are so close together.

It would therefore seem that the 25 r chamber can be used for measuring depth dose in the desired medium if the method described in the first part of this paper is observed. The average of several readings taken intracavitarily would give a good estimate of the dose received there.

If the ratio of opening to closure varies from that of 4 to 6, the depth doses obtained are different. The ratio of opening to closure in the grid investigated was 4 to 6. In another grid this ratio was 3.5 to 6.5, and the depth doses were measurably different. It is therefore important to provide a reproducible method of making the grids to exact specifications.

The results of this investigation for a 150 sq. cm. field are compared with those of Loevinger[12] in Table IV and, as is seen, they are in good agreement with each other.

The results were compared with the values obtained by plotting curves according to the method of Loevinger mentioned at the beginning of this paper from tables of depth doses by Bush.[1] The agreement is good at 10 cm. depth but only fair at 5 cm. depth and at the surface (see Table V). The measured values are higher than the calculated ones for both the scattered portion,

TABLE IV

COMPARISON OF DEPTH DOSES WITH THOSE OF LOEVINGER FOR A 150 SQUARE CENTIMETER FIELD

50 cm. T.S.D. Approx. 1 mm. Cu h.v.l

Depth in cm.	Open		Closed		Average	
	Jacobson and Lipman	Loevinger	Jacobson and Lipman	Loevinger	Jacobson and Lipman	Loevinger
5	57.5	57	25.4	23	38.2	37
10	27.8	25	15.6	13	20.5	18
15	11.9	12	8.2	7	9.7	9

i.e., underneath the covered portion of the grid, and for the total radiation underneath the holes.

DISCUSSION

The 250 r small air volume Victoreen chamber used in a phantom of suitable material with necessary provisions for centering offers a simple method for investigating the depth dose with a grid. The dose rate is measured under a hole to get the maximum radiation that any tissue might receive at the given depth and under a covered portion to get the minimum amount of radiation that the tissue would receive at the same depth. These two values are weighted and averaged to get the average dose rate for the tissue at that depth under the given conditions.

The 25 r "large" air volume chamber can also be used for these measurements. Here, the values obtained when exposed to maximum and minimum openings are given equal weight and averaged. This gives the average dose rate that is received at a given depth, but does not give any knowledge of the most intense or of the least intense radiations.

It would be interesting to investigate these depth doses with a thin wall chamber to see if more of the softer component is effective than has been measured with the regular chamber.

A probe chamber would give information about the gradient of the secondary radiation under the covered portion. We measured the density of blackening for different areas with a densitometer and found the average difference between the center and edges adjoining the holes to be less than 4 per cent.

The depth dose of the portion of the tissue underneath the openings falls off with the depth, while the depth dose of the portion underneath the covered part increases with the depth up to about 2 cm., after which there is a plateau up to about 4 cm. followed by a decrease. Sixty per cent of the skin, *i.e.*, the skin underneath the covered portion of the grid, is receiving less than the underlying tissue for a depth of from 7 to 9 cm., depending on the size of the portal. This may be one reason why the skin heals better with grid therapy than with ordinary therapy. It is not correct to assume that there are areas of irradiated skin surrounded by unirradiated skin, for a glance at Table 1 shows that even with small fields this portion is receiving 11–14 per cent, with medium size fields of 100–200 sq. cm. about 22 per cent, and with 300–400 sq. cm. fields about 26 per cent of the air dose. This is a considerable dose when the total dose given is as much as 24,000 r, measured in air.

TABLE V

COMPARISON OF DEPTH DOSES WITH THOSE CALCULATED FROM SEMILOG CURVES PLOTTED ACCORDING TO LOEVINGER[12] FROM BUSH DEPTH DOSE TABLES[1]

60 cm. T.S.D. Approx. 1 mm. Cu h.v.l.

Area of Field in Square Centimeters

Depth in cm.	For Openings					
	50		150		400	
	Measured	Calculated	Measured	Calculated	Measured	Calculated
0	116	110	119	115	125	118
5	54	50	64	59	73	65
10	20.4	21	27.2	27	34.2	34
	For Covered Portions					
0	13.6	10	22.7	15	27.3	19
5	18.8	16	27.0	22	35.2	31
10	10.2	9.7	15.9	15.5	22.7	22

TABLE VI

A COMPARISON OF THE NUMBER OF r DELIVERED WITH THE GRID AND WITHOUT THE GRID WHEN SKIN TOLERANCE DOSE IS ADMINISTERED IN EACH CASE

10 by 10 cm. Field, 50 cm. T.S.D., h.v.l. 1 mm. Cu Dosage Protracted Over One Month. Tolerance Dose With Grid 24,000 r in Air, and Without Grid 3,750 r in Air

Depth in cm.	Grid			Without Grid
	Open	Closed	Av.	
Surface	27,000	4,450	13,400	5,000
5	13,200	5,300	8,400	3,250
10	5,580	3,000	4,100	1,650
15	2,450	1,440	1,850	850

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TABLE VII

COMPARISON OF DEPTH DOSES WITH AND WITHOUT GRID FOR 100 r MEASURED ON THE SURFACE
h.v.l. 1 mm. Cu, T.S.D. 50 cm.
Area of Field in Square Centimeters

Depth in cm.	50		100		200		400	
	Av. with grid	Without grid[14]	Av. with grid	Without grid	Av. with grid	Without grid	Av. with grid	Without grid
Surface	100	100	100	100	100	100	100	100
5	57	58.4	62	64.6	68	70.6	71	75
10	24	27.6	30	32.8	35	38.8	39	45.4
15	10	13.2	14	16.9	17	21.3	20	26.3

In Table VI are listed the doses which are received on the surface, or skin, when 24,000 r is delivered with grid therapy and 3,750 r with conventional therapy, both measured in air, to an area of 100 sq. cm. The treatments are given in a month and the quality of radiation has a half-value layer of 1 mm. Cu. This is approximately the skin tolerance dose in each case. The tissue receives a greater dose even under the covered portion than in ordinary therapy. Yet, somehow, the "healing" effect on the skin when the grid is used is better than when it is not used. A theory or reasonable explanation for this behavior has still to be formulated.

When a comparison is made between the depth doses with the grid and those without the grid, if the surface dose averages 100 r, the grid depth doses are less than the conventional depth doses for the given field. This is shown in Table VII. Therefore, whatever advantage grid therapy has over regular therapy cannot be explained by an increase in the average depth dose of the grid over the depth dose of regular therapy.

The average depth doses of the grid at different distances for various sizes of fields are compared with those without the grid for 100 r, measured in air, in Table VIII.

We intend to continue this investigation to find the depth dose at the periphery of the field and other portions using 200 kv. and to do another study using 400 kv.

The clinical results will be published at some future time.

SUMMARY

1. Methods are described for measuring the depth dose with a perforated grid by using a presdwood phantom and (a) a small air volume 250 r Victoreen ionization chamber and (b) a "large" air volume 25 r Victoreen ionization chamber.

TABLE VIII

COMPARISON OF DEPTH DOSES WITH AND WITHOUT GRID FOR 100 r MEASURED IN AIR
h.v.l. 1 mm. Cu, T.S.D. 50 cm.
Area of Field in Square Centimeters

Depth in cm.	50		100		200		400	
	Av. with grid	Without grid[1]	Av. with grid	Without grid	Av. with grid	Without grid	Av. with grid	Without grid
Surface	54.7	126	56.1	133.9	60.4	141.0	65.0	145.2
5	31.0	73.5	34.9	86.5	41.0	99.5	45.9	108.9
10	12.8	34.8	16.6	43.9	20.9	54.6	25.2	66.0
15	5.7	16.6	7.7	22.6	10.1	30.0	13.0	38.2

2. Curves for the depth doses are given for the portion (a) underneath the central opening in the grid, (b) underneath the closed portion, (c) the average of these two, for a target-skin distance of 50 cm. and a target-skin distance of 60 cm. The fields varied from 50 sq. cm. to 400 sq. cm. The radiation was from a 200 kv. machine and had a half-value layer of 0.94 mm. Cu.

3. Tables of depth doses for conditions in 2 are given.

4. The results obtained with a 25 r chamber are compared with the average for the 250 r chamber and are found to be in good agreement, showing that either method could be used for obtaining depth dose measurements of the average.

5. A comparison is made between the dose received at various depths with the grid and without the grid for a 10 by 10 sq. cm. field when a skin tolerance dose is given in both cases over a period of one month.

6. A comparison is made of the depth doses with and without the grid (a) when 100 r is given on the surface (b) when 100 r is given in air at a target-skin distance of 50 cm., half-value layer 1 mm. Cu.

7. A comparison is given of the depth doses with those of Loevinger[12] and with those calculated by his method from tables of regular depth doses.

8. It was found that if the depth doses are known at one distance the depth doses at other distances can be calculated by using the inverse square law.

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THE GRID TECHNIQUE OF RADIOTHERAPY WITH DEPTH DOSE MEASUREMENTS*

By OSCAR H. COHEN, M.D.†, *and* WILLIAM L. PALAZZO, M.D.‡

IN RADIATION therapy the goal sought for has been the delivering of a lethal dose to the tumor without irreparable damage to the skin overlying it. With the grid technique herein described, the therapist can deliver dosages up to 20,000 roentgens in air, and more, in a period of seven to eight weeks and still preserve the ability of the skin to recover. Recently Jolles of England revived the idea of using multiple small portals in the roentgen therapy of malignant growths. His method is referred to as the "chess-board" method. Other synonyms for this type of application are the grid technique, perforator, sieve, and checkerboard techniques.

Whereas Jolles claims that his method is a new and complete departure from all existing methods, a review of the literature reveals that the idea was first utilized by Köhler of Germany in 1909. He suggested the principle of using multiple small portals in radiotherapy to save the skin and utilized it in treating deep tumors. Only sporadic interest in this technique was noted until recently, and the previous work by the American investigator Liberson in 1933 and 1936 apparently failed to arouse any further interest in this method. Goldfeder in 1939 demonstrated that large doses of radiation necessary for cell destruction could be applied through small portals without serious damage. Grynkraut in 1945, basing his work on Goldfeder's findings, devised a method of multiple small portals which supposedly reduced the backscatter to the skin. Most investigators recognized that the main purpose sought for in every method of treatment was the attainment of high dosage levels to the tumor.

Liberson's purpose in using the grid technique was to overcome the limiting factor of dosage to the skin since he believed that if islands of skin could be preserved for reparative purposes, much higher doses could be delivered through the exposed skin in the grid, thus attaining relatively higher dosages to the deep-seated tumor. Jolles' purpose is the preservation of connective tissue structures for regeneration and repair, and he questions the heretofore accepted principle of homogeneity of irradiation in the depth as necessary to the destruction of the tumor. Jolles, however, employs the reciprocal grid which is used after a sufficient time has elapsed during the treatment period, thus allowing for the protection and recovery of each area while the adjacent area is exposed to irradiation.

The present study is an attempt to determine the relative doses in the depth when radiation is delivered through a grid or sieve. In our early investigations, ionization measurements of dosages beneath the grids were made with the thimble chamber. These measurements, however, were discarded in favor of densitometric measurements for two reasons: (1) it was technically extremely difficult to accurately place the thimble chamber beneath the center of the small fields in the depths of the phantom, and (2) the size of available chambers was too large for the size of the grid openings.

For this study three lead rubber cut out grids of varying sizes were used and the results of densitometry readings were compared with dosages delivered through a conventional 10 by 15 cm. open lead rubber portal. The grids used were as

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follows: (1) 10 by 15 cm. with a checkerboard pattern of 1 cm. squares which permitted 50 per cent of the total area to be exposed (Fig. 1); (2) 10 by 15 cm. with a checkerboard pattern of 2 cm. sides (4 sq. cm.) which permitted 50 per cent of the total area to be exposed (Fig. 2); (3) 10 by 15 cm. with a checkerboard pattern of 1 cm. squares which permitted 26 per cent of the total area to be exposed. Figure 4 shows the effect under a 10 by 15 cm. open portal, while Figures 5, 6, 7 and 8 show the tangential effect of the various types of portals. The lead rubber used offered a protection of 0.9 mm. of lead equivalent. The physical factors used were 200 kv., Thoraeus filtration (0.44 mm. Sn, 0.25 mm. Cu, and 1.0 mm. Al), 50 cm. target-skin distance, 10 by 15 cm. cone, and 15 ma. All measurements were made in a presdwood phantom of unit density measuring

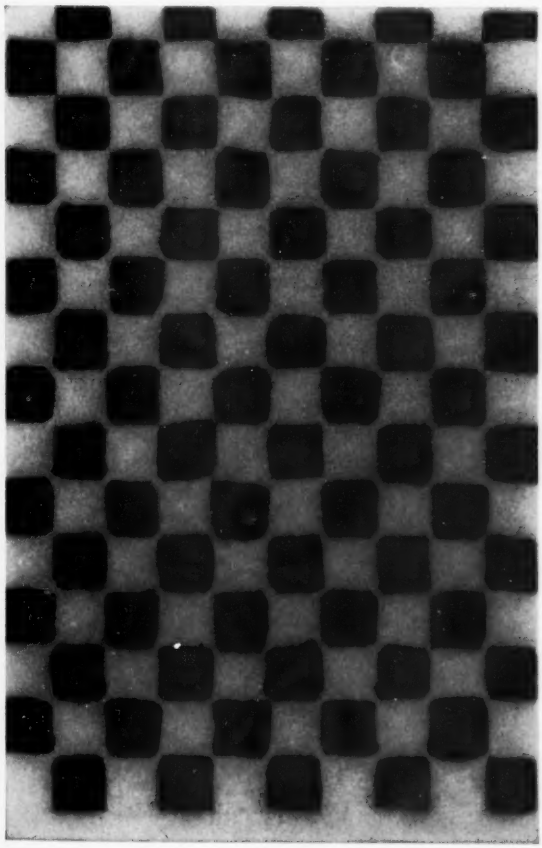

Fig. 1

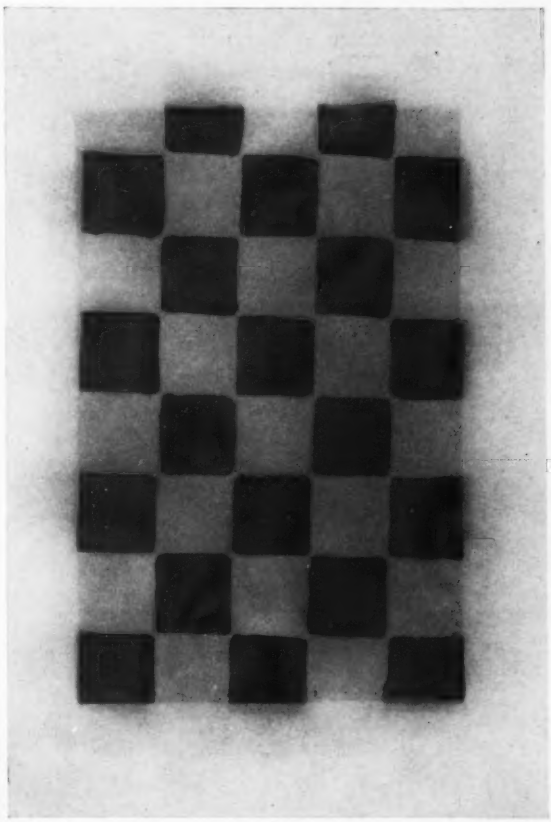

Fig. 2

30 by 30 by 30 cm. Simultaneous exposures were made on all films in each group and the processing technique was carefully controlled. Each set of films irradiated was given an exposure of eight seconds which delivered 1.77 roentgens in air at the 50 cm. distance.

The densities obtained through the 10 by 15 cm. open portal were used as the standard and plotted on semilogarithmic graph paper against standard depth dose tables (Glasser, Quimby, Taylor and Weatherwax) (Fig. 9). The results were further checked by delivering known quantities of roentgens to films and thus calibrating the film densities. From this graph, percentage depth doses were then obtained from the densities recorded on films placed at various depths beneath the different type grids. All readings included back scatter. Density readings were made directly under open and covered areas of the

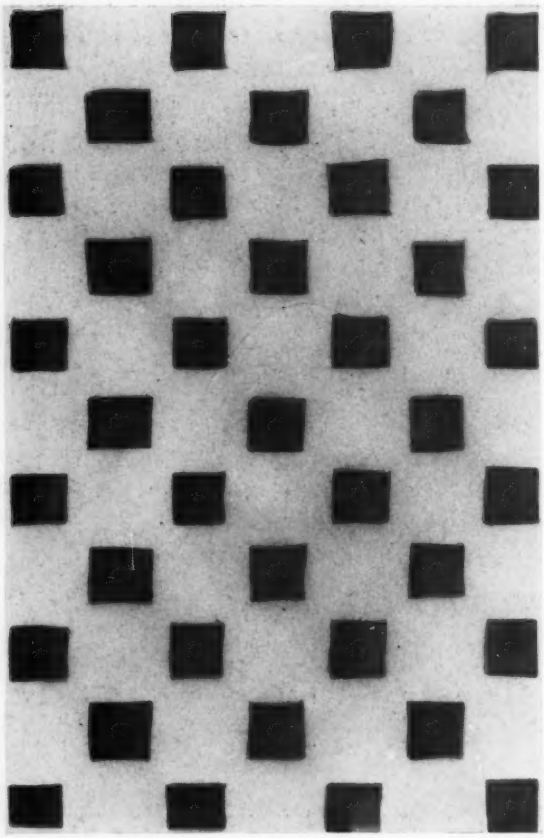

FIG. 3

respective grids. Figure 10 shows relative depth dose percentages in these areas. Figure 11 shows relative depth dose percentage curves obtained with the various techniques. Figure 12 shows percentage of depth doses under the grids as compared to depth doses under the 10 by 15 cm. open portal as 100 per cent in each case at each level in the depth. Figure 13 is a graphic illustration of Figure 12.

ANALYSIS OF DATA

Figures 10 and 11 show that the depth doses under all types of grids are less than those obtained under a 10 by 15 cm. open portal. It also is apparent that the depth dose percentages are greater under the 1 cm. grid with 50 per cent exposed area than under the 2 cm. grid with the same area exposed. In turn, the latter grid shows a greater percentage depth dose than the 1 cm. grid with only 26 per cent exposed area. Immediately under the grids there exists a large difference between the percentage depth doses obtained below the exposed and protected areas. With increasing depth these differences tend to become smaller and the percentage depth doses tend to approach each other.

In the intermediate depths (about 5 cm. level) the percentage depth dosage under the protected areas increases slightly over the skin dose level immediately below the protected areas (Fig. 10). This is probably due to the summation of both forward and back scatter at these depths. Under the open areas this effect does not occur and the percentage depth doses decrease as expected. An unexplained finding was the fact that the skin dose obtained by densitometric reading in an exposed area of the 1 cm. grid with 50 per cent exposed area was higher than that obtained with the 10 by 15 cm. open portal.

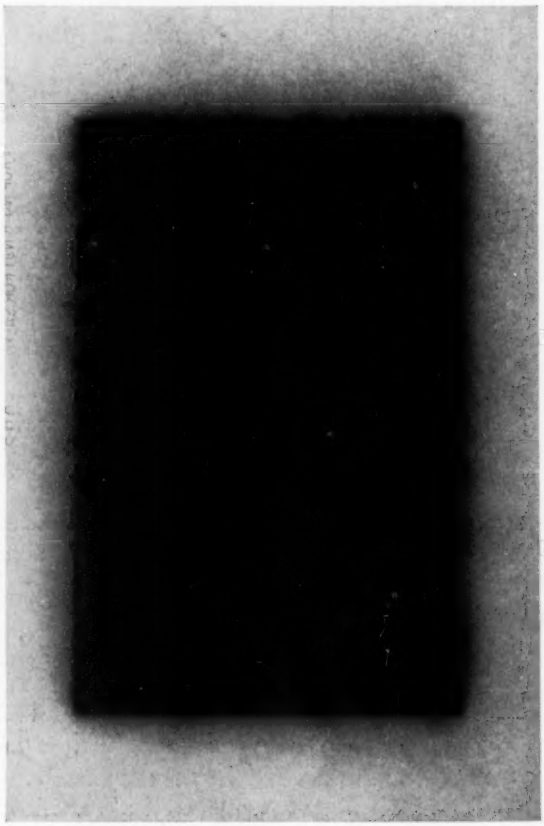

FIG. 4

FIG. 5

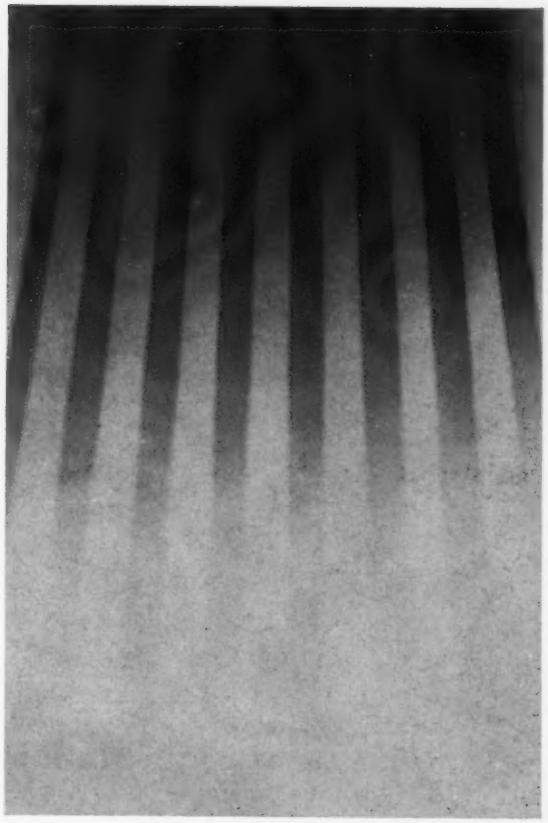

FIG. 6

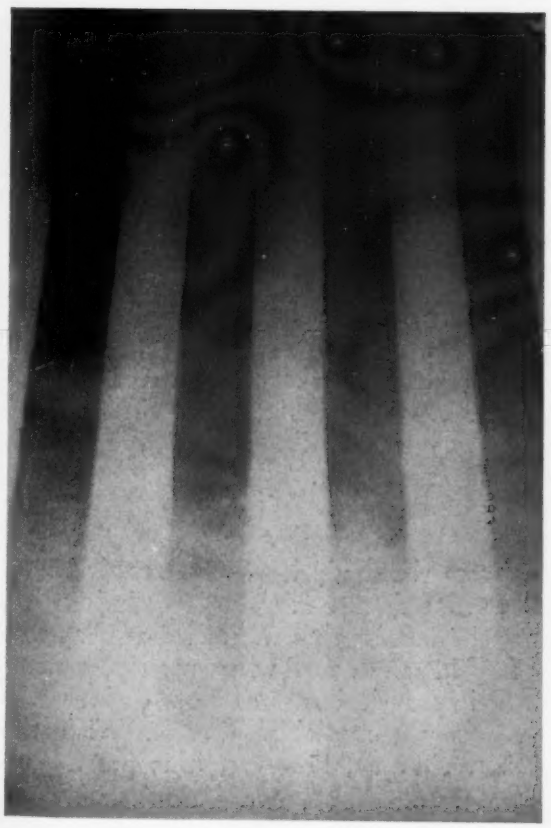

FIG. 7

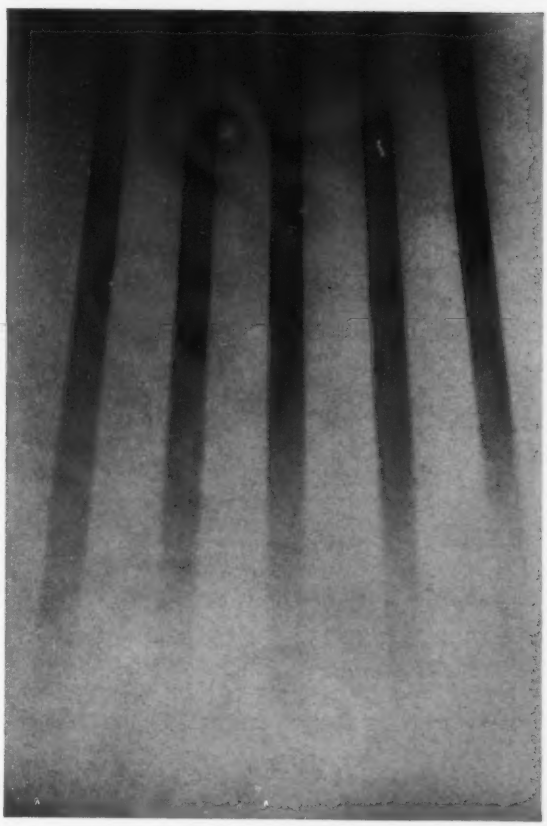

FIG. 8

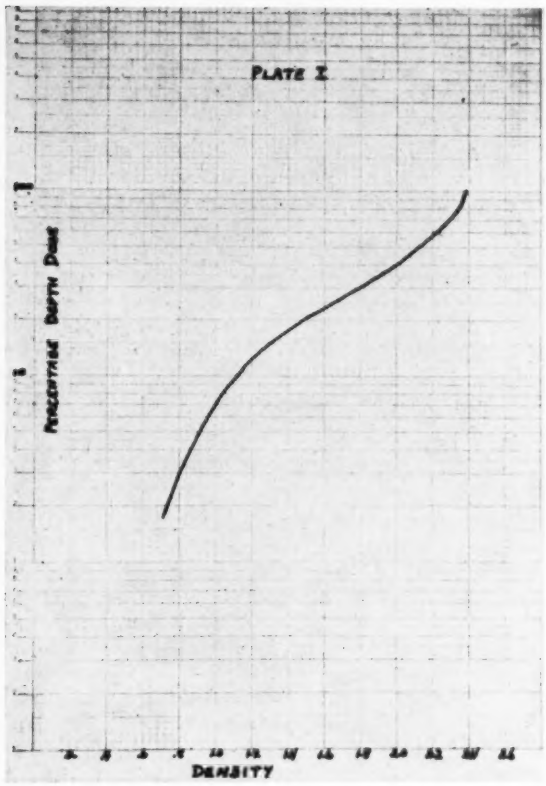

FIG. 9

Figures 12 and 13 show that below the 5 cm. depth the percentage dosages obtained under the exposed and protected areas are greater than 50 per cent of the expected dose under a 10 by 15 cm. open portal in spite of the fact that 50 per cent of the skin was protected. The relative percentage depth doses under the 2 cm. grid with 50 per cent exposed area and the 1 cm. grid with 26 per cent exposed area are less than 50 per cent.

From the illustrations it seems apparent that the most suitable grid is the 1 cm. grid with 50 per cent of the area exposed because the relative depth doses are higher than with either of the other grids and also there is less difference in the dosages beneath the covered and exposed areas. This latter tends to produce a more homogeneous distribution of delivered radiation to the depth.

Depth in cm.	Open area		Covered area		
	Density	%	Density	%	
0	2.60	110*	1.80	31	1 cm. Grid(50% open area)
5	2.14	46	1.86	35	
10	1.73	27	1.59	25	
15	1.25	15	1.14	11	
0	2.26	66	1.22	13	1 cm. Grid(26% open area)
5	1.77	29	1.31	15	
10	1.34	16	1.04	8	
15	.82	3	.75	2	
0	2.22	60	1.48	20	2 cm. Grid(50% open area)
5	1.98	39	1.69	27	
10	1.56	22	1.43	18	
15	1.17	12	1.08	9	
0	2.38	100			10x15 cm. open portal
3	2.34	83			
5	2.26	66			
8	2.07	45			
10	1.95	36			
13	1.68	26			
15	1.52	21			
18	1.26	14			
20	1.12	10			

*estimated

FIG. 10

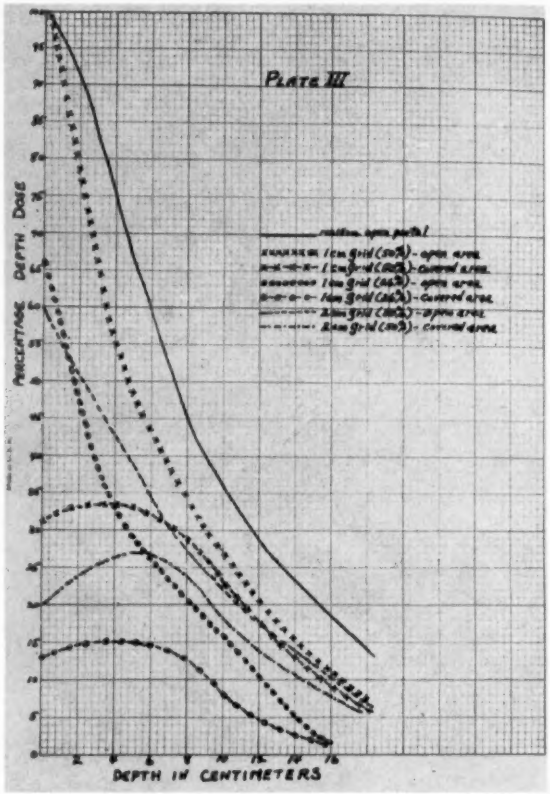

FIG. 11

DISCUSSION

From the analysis of the data, it is evident that the use of the grid technique has certain definite though limited application. The grid can be used where multiple portals are impractical or cannot deliver the necessary tumoricidal dosage. With the grid technique, however, it is possible to

use two or more portals and obtain adequate lethal dosages. Advantage is taken of the fact that islands of skin and connective tissue which are thus protected enables recovery of tissue exposed to unusually high doses of radiation. The ability to recover is necessarily limited by the amount of radiation received by the protected areas.

Relatively superficial lesions will receive dosages which are so heterogeneous as to question the use of the grid in these situations. It may be necessary to use reciprocal grids in these situations to overcome this limitation. With the use of reciprocal grids, however, due to divergence of beams,

Depth in cm.	Percentage	
	Open area	Covered area
0	110	31
5	75	50
10	76	64
15	62	58
1 cm. Grid (50% open area)		
0	66	13
5	44	25
10	44	22
15	14	16
1 cm. Grid (36% open area)		
0	60	20
5	59	41
10	61	50
15	59	45
2 cm. Grid (50% open area)		

Fig. 12

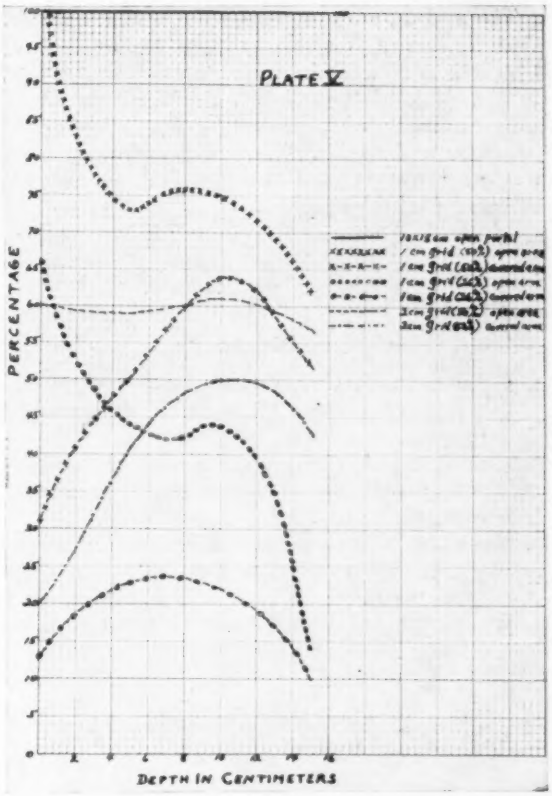

Fig. 13

symmetrical "hot spots" will occur in the depth. This effect must be taken into consideration when reciprocation is contemplated.

In the use of the grids it is imperative that the grids be placed accurately during the course of therapy so that the same areas of skin are constantly irradiated in the same manner. The English practice of using plaster or composition casts may be employed to achieve this purpose, especially when the grids are applied to irregular contours of the body.

Extensive clinical application is necessary to evaluate the efficacy of the grid technique. The maximum amount of irradiation that the skin can tolerate must be determined not only for the immediate recovery but also for the possible latent effects. Further study may indicate that other grid patterns may be more ideal, both as to skin tolerance and homogeneity of depth dosages. In this event depth dose measurements have to be determined for each different pattern being evaluated.

SUMMARY

1. Densitometry readings have been taken to determine depth dose distribution beneath three types of grids.

2. The most practical grid arrangement appears to be the 1 cm. grid with 50 per cent exposed area.

3. Although there exists a vast difference in the percentage depth dose in the exposed and covered areas immediately beneath the grid, yet with increasing depth these differences tend to become smaller and even approach each other.

4. An unexpected homogeneity of dosage is evident in the depths beyond 5 cm.

5. The grid technique may offer limited advantages over the conventional methods of radiation therapy.

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Thirty-fourth Annual Meeting: Stevens Hotel, Chicago, Ill., June 8, 9 and 10, 1952.

EDITORIALS

THE ROENTGEN ASPECTS OF PULMONARY ARTERIOVENOUS FISTULA

PULMONARY arteriovenous fistula is thought to be a relatively rare finding, but is it? Within the space of thirteen years since Smith and Horton[1] first reported their case of pulmonary arteriovenous fistula of the lung associated with polycythemia vera in which the diagnosis was made clinically, there are now more than sixty-five proved cases in the medical literature.

Quite recently, Seaman and Goldman[2] have reviewed the roentgenographic experience with eight cases of pulmonary arteriovenous fistula for the purpose of determining the reliability of the diagnostic roentgen criteria, and in this article they discuss the role of roentgenography in the diagnosis of this supposedly rare condition.

If a patient presents himself with the clinical features of cyanosis and clubbed fingers, associated with polycythemia and a pulmonary murmur, the clinical syndrome of pulmonary arteriovenous fistula may be easily recognized if the physician is aware of the entity. However, as Goldman[3] has pointed out, a large proportion of these cases are associated with cutaneous and mucosal hemangiomas and telangiectases of a hereditary nature which probably represent a variant of Rendu-Weber-Osler disease.

With the gradual accumulation of cases and the study of these, it is evident that the classical clinical picture associated with a large pulmonary arteriovenous shunt and corresponding changes in the peripheral blood is not always present, and it is clear from many of the cases reported that the roentgen appearance in pulmonary arteriovenous fistula may be the only positive finding leading to a correct diagnosis, as was suggested by Wodehouse.[4]

It is of considerable importance that this pulmonary anomaly be recognized roentgenographically if not clinically since it may be cured by the intervention of surgery.

Seaman and Goldman, in analyzing their cases, observed that the sex incidence is evenly divided, and the age incidence ranged from twenty-two to seventy-nine years, and apparently from their study pulmonary arteriovenous fistula is compatible with longevity.

Since the roentgen examination of the chest is being more universally employed, it is not unlikely that many cases of asymptomatic pulmonary arteriovenous fistula may be discovered. However, this does not lessen the responsibility of the examiner in recognizing this pathologic process.

Seaman and Goldman state also that there have been extremely few cases of this condition reported in children; this, in spite of the fact that it is probably a congenital anomaly in the pulmonary circulation.

Since in at least 50 per cent of the cases reported there was absence of clubbing of the fingers, cyanosis, and polycythemia, greater reliance must of necessity

[1] Smith, H. L., and Horton, B. T. Arteriovenous fistula of lung associated with polycythemia vera. *Am. Heart J.*, 1939, *18*, 589–592.

[2] Seaman, W. B., and Goldman, A. Roentgen aspects of pulmonary arteriovenous fistula. *A.M.A. Arch. Int. Med.*, Jan., 1952, *89*, 70–81.

[3] Goldman. A. (a) Cavernous hemangioma of lung; secondary polycythemia. *Dis. of Chest*, 1943, *9*, 479–486; (b) Arteriovenous fistula of lung. *Am. Rev. Tuberc.*, 1948, *57*, 266–280.

[4] Wodehouse, G. E. Hemangioma of lung. *J. Thoracic Surg.*, 1948, *17*, 408–415.

be placed on the roentgen examination for the recognition of the nature of the underlying pulmonary pathology.

Since the roentgenological examination plays such an important part in the recognition of these pulmonary arteriovenous fistulas, Seaman and Goldman, and previously Lindgren,[5] have emphasized the roentgenological aspects of the condition. Most observers agree that the lesion is usually lobulated or round, with smooth discrete margins and has a predilection for the lower lobes or the right middle lobe, upper lobe involvement being much less frequent. There are present two or more sinuous linear shadows which represent the dilated afferent and efferent blood vessels connecting the mass with the hilus, and a characteristic feature of these vessels is that they are usually larger than the pulmonary vessels in the vicinity and their course is more tortuous. The veins are more widely dilated than the arteries, owing to the transmission of arterial pressure directly into the veins. The characteristic roentgen picture is one of tortuous band-like shadows communicating with the hilus and with a lobulated soft-tissue tumor in the pulmonary parenchyma. Careful observation of the vessels running through the hilus to the pulmonary opacity may give a clue to the true nature of the underlying lesion.

Lindgren was the first to make note of the importance of the use of the Valsalva and the Müller experiments in order to bring out the vascular character of the lesion. That these two tests are of considerable importance is also emphasized by Seaman and Goldman in their report since in about one-half of the published cases in which these tests were carried out a positive response was elicited. It is recommended that these experiments should be routinely employed at the time of the roentgenoscopic investigation of all suspected cases of pulmonary arteriovenous fistula. It is difficult roentgenoscopically in many cases to decide definitely whether the aneurysm has pulsations of its own and not merely transmitted pulsations, and Lindgren suggested that possibly kymographic recordings may give a more definite answer to this question. That his surmise in this respect was correct is shown by the fact that Seaman and Goldman, employing the kymograph in the study of some of their cases, were able to definitely demonstrate the presence of pulsations in the aneurysmal mass.

The heart in these cases of pulmonary arteriovenous fistula is not enlarged, in contrast to the enlargement of the heart noted in many cases of arteriovenous fistula involving the systemic circulation. Lindgren in his report emphasized the relationship of the pulmonary mass to the pulmonary vascular shadows as the most significant roentgen diagnostic signs of this lesion. By the employment of laminagraphic studies this relationship may be definitely established and it is suggested that laminagrams be taken in both the lateral and frontal projections whenever pulmonary arteriovenous fistula is suspected. This procedure may demonstrate lesions not previously recognized on conventional roentgenograms and, in addition, it helps to indicate the lesion's exact position in the bronchopulmonary segment. By the use of laminagraphy one may accurately locate the lesion in its correct anatomic position and demonstrate the afferent and efferent vessels. Seaman and Goldman, however, state that it may be extremely difficult to differentiate pulmonary artery from pulmonary vein in the upper lobe lesions by means of laminagraphy and they have employed bronchography as an aid in differentiating saccular bronchiectatic cavities filled with secretions which may simulate the roentgen appearance of arteriovenous fistula.

They, as well as Lindgren, point out the great aid which angiography may give in not only establishing the true nature of these lesions but also the extent of the lesion. However, in patients exhibiting a

[5] Lindgren, E. Roentgen diagnosis of arterio-venous aneurysm of lung. *Acta radiol.*, 1946, *27*, 585–600.

hypertension or evidence of cardiac failure, the employment of angiocardiography as a diagnostic aid is fraught with certain hazards and is clearly contraindicated. Seaman and Goldman believe that with the use of conventional roentgenography and of laminagraphy a definite diagnosis can be made without resorting to angiography in the vast majority of the cases, but in those cases in which surgical intervention is contemplated angiographic studies are indicated as this gives a true picture of the pulmonary circulation and of the size and location of the involved vessels, as well as the identification of anomalous origins of the afferent artery or anomalous insertions of the efferent veins, which helps to facilitate the surgical treatment. And again angiocardiography often demonstrates the presence of multiple lesions which may be overlooked in the conventional roentgenograms as well as in the laminagraphic studies. It is needless to point out the importance of demonstrating bilateral involvement in arriving at a decision as to operability.

Since pulmonary arteriovenous fistulas are much more common than the literature would lead one to believe, it behooves the roentgenologist to acquaint himself with the roentgenographic appearance of these lesions in the conventional film studies in order that he may institute other roentgenographic methods not only in arriving at an exact diagnosis but also in learning the extent of the pulmonary arteries and veins involved in the pathologic process.

JOHN MILLER WOODBURN MORISON, M.D., F.R.C.P.E., F.F.R.

"DEATH hath this also, that it openeth the gate to good fame and extinguisheth envy." "Pop" Morison was a character. We have no sooner lamented the dearth of characters in medicine to-day than we find ourselves saddened by the loss of yet another well-loved personality. John Miller Woodburn Morison had an appearance worthy of his name; built on the grand scale with a high forehead surrounded by a halo of unruly hair, he had the presence and manner of a famous actor, and looked like a distinguished professor ought to look and so seldom does. It was the voice that added the finishing touch, deep and resonant with a glorious Scottish accent to adorn the good stories with which he continually delighted us. Characters are rarely consistent or predictable, and he was one "rather to run the risk of falling into faults in a course which leads us to act with effect and energy, than to loiter out our days without blame, and without use," though, being a man of parts, he was an expert in the art of loitering too.

I did not meet him until four years after he had been appointed to the first Chair of Radiology in this country by the University of London at the Royal Cancer Hospital, but it was clear that things had happened wherever he had been. Coming from a doctor's family in Ayrshire, he was taken from general practice to India by the 1914–18 war, where his interest was directed to radiology. He was fortunate in having the friendship of Thurstan Holland and in working in Manchester with A. E. Barclay, two of the great figures in the formative years of radiology, not only in this country but in the world. He left Manchester in 1925 to take charge of the radiological department at the Edinburgh Royal Infirmary, and promptly raised it from the basement to a large new building which was opened by the King, who was then Duke of York. When he came to the Royal Cancer Hospital in 1930 he again moved to a fine new building, and sitting now at his desk remembering him, I record with gratitude how characteristically he secured the best room in the new hospital

Photograph by Jean Weinberg

building for his own. Here he laid the foundations for the developments which were to follow; he created an independent physics department and provided the opportunity for it to flower; he charmed money from willing benefactors and re-equipped both diagnostic and therapy

sides, being the first by several years to install 400 kV apparatus. Without the originality of Robert Knox who came before him, many of whose ideas are now being rediscovered with enthusiasm, Morison had the drive and authority which gave status to his department and allowed a development which Knox had been unable to achieve. Both in Edinburgh and London he organised the first courses for new diplomas in medical radiology, and his students will long remember him as a fine lecturer, whose digressions were a joy, and as a kindly man who made the problem of finding each one his first job in radiology his own.

His honours were many both at home and abroad. He was President of his section of the Royal Society of Medicine, President of the British Association of Radiologists, which became the Faculty of Radiologists, and a member of many foreign radiological societies. He joined The British Institute of Radiology in 1914. In 1938 he retired rather sadly, soon to return joyfully to join the E.M.S. and work throughout the war. He continued to the end to give a course of lectures each year at Cairo University, and to act as advisor and visiting professor of radiology at Farouk University in Alexandria. He died suddenly walking in his garden at Bexhill-on-Sea on September 3, at the age of 76, and there are many people in many countries who, having a deep affection for this lovable if sometimes difficult man, will think with regret that they will not again admire the solemnity and air of wisdom with which he would pronounce his considered judgment on a difficult film with the words, "Well ye reely can't tell."

D. W. Smithers

Dr. Woodburn Morison was an honorary member of the American Roentgen Ray Society and was well known and highly regarded by many of the radiologists in the United States. The obituary and photograph are reprinted by permission from the *British Journal of Radiology*, October, 1951, *24*, 580.—Ed.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. Barton R. Young, Germantown Hospital, Philadelphia 44, Pa. Annual meeting: Shamrock Hotel, Houston, Texas, September 23, 24, 25 and 26, 1952.

American Radium Society
Secretary, Dr. J. E. Wirth, 635 Herkimer St., Pasadena 1, Calif. Annual meeting: Stevens Hotel, Chicago, Ill., June 8, 9 and 10, 1952.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 713 E. Genesee St., Syracuse 2, N. Y.

American College of Radiology
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6, Illinois.

Section on Radiology, American Medical Association
Secretary, Dr. T. Leucutia, Harper Hospital, Detroit 1, Mich.

Alabama Radiological Society
Secretary, Dr. J. A. Meadows, Jr., Medical Arts Bldg., Birmingham 5, Ala. Meets time and place Alabama State Medical Association.

Arizona Radiological Society
Secretary, Dr. R. Lee Foster, 507 Professional Building, Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

Arkansas Radiological Society
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

Atlanta Radiological Society
Secretary, Dr. J. D. King, 35 Linden Ave., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

Brooklyn Roentgen Ray Society
Secretary, Dr. J. J. Daversa, 345 75th St., Brooklyn, N. Y. Meets monthly fourth Tuesday, October through April.

Buffalo Radiological Society
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

Central New York Roentgen Ray Society
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

Central Ohio Radiological Society
Secretary, Dr. F. A. Riebel, 15 West Goodale St., Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Columbus Athletic Club, Columbus, Ohio.

Chicago Roentgen Society
Secretary, Dr. B. D. Braun, 6 N. Michigan Ave., Chicago 2, Ill. Meets second Thursday of each month, October to April inclusive at the University Club.

Cleveland Radiological Society
Secretary, Dr. Mortimer Lubert, 10515 Carnegie Ave., Cleveland 6, Ohio. Meetings at 6:45 P.M. on fourth Monday of each month from October to April.

Colorado Radiological Society
Secretary, Dr. W. P. Stampfli, 1933 Pearl St., Denver, Colo. Meets third Friday of each month at University of Colorado Medical Center or at Denver Athletic Club.

Connecticut Valley Radiologic Society
Secretary, Dr. E. W. Godfrey, 1676 Boulevard, West Hartford, Conn. Meets second Friday October and April.

Dallas-Fort Worth Roentgen Study Club
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. J. C. Cook, Harper Hospital, Detroit, Mich. Meets monthly first Thursday, October to May, at Wayne County Medical Society Building.

East Bay Roentgen Society
Secretary, Dr. Dan Tucker, 434 30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

Florida Radiological Society
Secretary, Dr. Nelson T. Pearson, 1109 Huntington Bldg., Miami, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

Georgia Radiological Society
Secretary, Dr. R. C. Pendergrass, Americus, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

Greater Miami Radiological Society
Secretary, Dr. Maurice Greenfield, Ingraham Bldg., Miami, Fla. Meets third Wednesday of each month at Veterans Administration Building.

Houston Radiological Society
Secretary, Dr. F. M. Windrow, 1205 Hermann Professional Bldg., Houston, Texas. Meets fourth Monday each month.

Illinois Radiological Society
Secretary, Dr. Stephen L. Casper, 1101 Maine St., Quincy, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. William M. Loehr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

Iowa X-Ray Club
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society.

Kansas Radiological Society
Secretary, Dr. Charles M. White, 3244 E. Douglas, Wichita 8, Kan. Meets annually with State Medical Society.

Kentucky Radiological Society
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Seelbach Hotel, Louisville.

Kings County Radiological Society
Secretary, Dr. Marcus Wiener, 1430 48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

Los Angeles Radiological Society
Secretary, Dr. John B. Hamilton, 210 N. Central Ave., Glendale 3, Calif. Meets second Wednesday each month at Los Angeles County Medical Association Building.

Louisiana Radiological Society
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

Maine Radiological Society
Secretary, Dr. C. F. Miller, Central Maine General Hospital, Lewiston, Maine.

Miami Valley Radiological Society
Secretary, Dr. G. A. Nicoll, 134 Apple St., Dayton, Ohio. Meets second Friday of fall and winter months.

* Secretaries of societies are requested to send timely information promptly to the Editor.

Michigan Association of Roentgenologists
President, Dr. Horace W. Porter, 505 Wildwood Ave., Jackson, Mich.

Mid-Hudson Radiological Society
Secretary, Dr. J. W. Walton, Horton Memorial Hospital, Middletown, N. Y. Meets 8:30 P.M., fourth Tuesday each month, September to May.

Milwaukee Roentgen Ray Society
Secretary, Dr. T. J. Pfeffer, 839 N. Marshall St., Milwaukee 2, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. L. A. Nash, 572 Lowry Medical Arts Bldg., St. Paul 2, Minn. Meets three times annually, once at time of State Med. Assn., and in spring and fall.

Mississippi Radiological Society
Secretary, Dr. John W. Evans, 621 High Street, Jackson 2, Miss. Meets third Thursday of each month at the Rotisserie Restaurant at 6:30 P.M.

Nebraska Radiological Society
Secretary, Dr. R. W. Blanchard, 1216 Medical Arts Bldg., Omaha, Nebr. Meets fourth Thursday of each month at 6 P.M. at Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. L. L. Robbins, Massachusetts General Hospital, Boston, Mass. Meets monthly on third Friday, Harvard Club.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. Irving Schwartz, 45 E. 66th St., New York 21, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. J. E. Hemphill, 1420 E. Fifth St., Charlotte 4, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings by announcement.

Northeastern New York Radiological Society
Secretary, Dr. John F. Roach, Albany Hospital, Albany, N. Y. Meets on the second Wednesday of October, November and March at the University Club, Albany. Annual meeting in June to be announced.

Northern California Radiological Club
Secretary, Dr. G. A. Fricker, Sacramento County Hospital, Sacramento, Calif. Meets at dinner last Monday, every second month, except June, July and August.

Ohio State Radiological Society
Secretary, Dr. Willis S. Peck, 2001 Collingwood Blvd., Toledo, Ohio.

Oklahoma State Radiological Society
Secretary, Dr. W. E. Brown, 21st & Xanthus, Tulsa 4, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. J. Richard Raines, 214 Medical-Dental Bldg., Portland 5, Oregon. Meets monthly from October to June on the second Wednesday of each month at 8:00 P.M. at the University Club.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport. Annual meeting: Bedford Springs Hotel, Bedford, Pa., May 16 and 17, 1952.

Philadelphia Roentgen Ray Society
Secretary, Dr. G. P. Keefer, American Oncologic Hospital, Philadelphia 4, Pa. Meets first Thursday each Month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. E. J. Euphrat, 3500 Fifth Ave., Pittsburgh 13, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Richard B. Hanchett, 705–6 Medical Arts Bldg., Baltimore, Md. Meets third Tuesday each month, September to May.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Fred. Zaff, 135 Whitney Ave., New Haven, Conn. Meets bimonthly on second Wednesday.

Radiological Section, Medical Society of the District of Columbia
Secretary, Dr. U. V. Wilcox, 915 Nineteenth St., N. W., Washington 6, D. C. Meets Medical Society Library, third Thursday of January, March, May and October at 8:00 P.M.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Radiological Society of Greater Cincinnati
Secretary, Dr. Lee S. Rosenberg, Jewish Hospital, Cincinnati 29, Ohio. Meets first Monday each month, October through May.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

Radiological Society of New Jersey
Secretary, Dr. Nicholas G. Demy, 912 Prospect Avenue, Plainfield, N. J. Meets annually at Atlantic City at time of State Medical Society and mid-winter at Elizabeth, N. J.

Richmond County Radiological Society
Secretary, Dr. W. F. Hamilton, Jr., University Hospital, Augusta, Ga.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. George Gamsu, 191 S. Goodman St., Rochester, N. Y. Meets monthly on last Monday from September through May, 8:00 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr.

St. Louis Society of Radiologists
Secretary, Dr. Francis O. Trotter, Jr., 634 N. Grand Blvd., St. Louis 3, Mo. Meets fourth Wednesday each month, except June, July, August and September.

San Diego Radiological Society
Secretary, Dr. Rex Uncapher, 7720 Girard Ave., La Jolla, Calif. Meets first Wednesday of each month at the University Club.

San Francisco Radiological Society
Secretary, Dr. I. J. Miller, 2680 Ocean Avenue, San Francisco 27, Calif. Meets quarterly.

Section on Radiology, California Medical Association
Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. Harold L. Shinall, St. Joseph's Hospital, Bloomington, Ill.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Bay Radiological Society
Secretary, Dr. Ford Shepherd, 526 Soquel Avenue, Santa Cruz, Calif. Meets second Wednesday each month.

South Carolina X-Ray Society
Secretary, Dr. Henry E. Plenge, Spartanburg General Hospital, Spartanburg, S. C. One meeting with South Carolina Medical Association in May, others arranged by President.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, Newell Hospital, Chattanooga,

Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7:00 p.m. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 p.m., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

Utah State Radiological Society
Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. John N. Burkey, 555 Medical-Dental Bldg., Seattle 1, Wash. Meets fourth Monday of each month from September through May.

Westchester Radiological Society
Secretary, Dr. Walter J. Brown, Northern Westchester Hospital, Mt. Kisco, N. Y. Meets on third Tuesdays of January and October and on two other dates to be announced.

Wisconsin Radiological Society
Secretary, Dr. Irving I. Cowan, 425 E. Wisconsin Ave., Milwaukee 2, Wis. Special meetings held during year; annual meeting each spring at Madison, Wis.

X-Ray Study Club of San Francisco
Secretary, Dr. Charles E. Duisenberg, Palo Alto Clinic, 300 Homer Ave., Palo Alto, Calif. Meets third Thursday at 7:45 p.m., January to June, Lane Hall, Stanford University Hospital; July to December, San Francisco Hospital.

Cuba, Mexico and Central America

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Sociedad Mexicana de Radiologia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

Sociedad Radiológica Panameña
Secretary, Dr. L. Arrieta Sanchez, Apartado No. 86, Panama, R. de P. Meets monthly in a department of radiology of a local hospital, chosen at preceding meeting.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 p.m.
Medical Members' meeting, on third Friday in each month at 5:00 p.m., 32 Welbeck St., London, W 1.

Faculty of Radiologists
Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 p.m. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary-Treasurer, Dr. Jean Bouchard, Suite 305, 1555 Summerhill Avenue, Montreal 26, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Française d'Electrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

Australian and New Zealand Association of Radiologists
Honorary Sectetary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.

Honorary Secretaries, State Branches:
New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.
Victoria, Dr. T. L. Tyrer, 3 Lockerbie Court, East St. Kilda.
Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.
South Australia, Dr. R. deG. Burnard, 170 North Terrace, Adelaide.
Western Australia, Dr. A. M. Nelson, 179 B St. Georges Terrace, Perth.
New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

South America

Asociacion Argentina de Radiologia
Secretary, Dr. Lidio G. Mocsa, Avda. Gral Paz 151, Córdoba, Argentina. Meetings held monthly.

Sociedad Argentina de Radiologia, Junta Central, Buenos Aires
Secretary, Dr. Oscar F. Noguera, Santa Fe 1171, Buenos Aires. Meetings are held monthly.

Sociedad Argentina de Radiologia, Filial del Litoral, Sede, Rosario
President, Dr. Francisco P. Cifarelli. Meets monthly second Wednesday, 19 ha 663 Italia St., Rosario, Santa Fe.

Sociedad Argentina de Radiologia, Filial del Sur, Sede, La Plata
President, Prof. Dr. Jose P. Uslenghi, La Plata. Meets monthly.

Sociedad Argentina de Radiologia, Filial del Centro, Sede, Cordoba
President, Prof. Dr. David L. Caro, Corro 86, Cordoba. Meets monthly.

Sociedad Argentina de Radiologia, Filial del Norte, Sede, Tucuman
President, Dr. Julio Mendez Valladares, Rivadavia 358, Tucuman. Meets monthly.

Sociedad Argentina de Radiologia, Filial de Cuyo Sede, Mendoza.
President, Dr. J. A. Orfila, Hospital Central, Mendoza. Meets monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Oscar Rocha von Pfuhl, Av. Brigadeiro Luiz Antonio, 644 São Paulo, Brazil. Meets monthly on second Wednesday at 9:00 p.m. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Colombiana de Radiologia
Secretary, Dr. Alberto Torres Focke, Av. 34, No. 17–34, Bogota, Colombia. Meets last Wednesday of each month.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

Sociedad de Radiologica, Cancerologia y Fisica Medica del Uruguay
Secretary, Dr. Arias Bellini, Av. Agraciada 1464, Piso 13, Montevideo, Uruguay.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Allies, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

SOCIÉTÉ FRANÇAISE D'ELECTRO-RADIOLOGIE MÉDICALE, and its branches: SOCIÉTÉ DU SUD-OUEST, DU LITTORAL MÉDITERRANÉEN, DU CENTRE ET DU LYONNAIS, DE L'OUEST, DE L'EST, ET D'ALGER ET D'AFRIQUE DU NORD
Secretary-General, Dr. A. Dariaux, 9 bis, Boulevard Rochechouart, Paris IX^e, France.

CESKOSLOVENSK SPOLEČNOST PRO RËNTGENOLOGII A RADIOLOGII V PRAZE
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland.

GDANSK SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10:30, X-Ray Dept., Akademia Gdansk.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT (SOCIÉTÉ SUISSE DE RADIOLOGIE)
Secretary, Dr. Max Hopf, Effingerstrasse 47, Bern, Switzerland.

DEUTSCHE ROENTGEN-GESELLSCHAFT
Honorary President, Prof. Dr. F. Haenisch, Wentzelstrasse 14 I, (24a) Hamburg 39, Germany. Meets annually in different towns.

SOCIETA ITALIANA DR RADIOLOGIA MEDICA
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano. Torino, Italy. Meets biannually.

INDIA

INDIAN RADIOLOGICAL ASSOCIATION
Secretary, Dr. R. F. Sethna, Navsari Building, Hornby Road, Bombay 1, India.

ASOCIACION ARGENTINO DE RADIOLOGIA

The fourth Congress of the Asociación Argentino de Radiología will be held from July 23 to July 26, 1952, in Santa Fe, Argentina.

The following main topics will be discussed:

1. Cancer of the Breast—Radiologic Diagnosis, Surgical Treatment, Radiation Treatment and Pathology.

2. Malignant Tumors of the Bones—Surgical Treatment, Radiation Treatment, Radiologic Diagnosis and Pathology.

3. Roentgen Diagnosis of Abdominopelvic Tumors.

A cordial invitation is extended to American radiologists to attend the Congress. The Chairman of the Congress is Dr. Raúl Mayer, San Jerónimo 3472, Santa Fe, Argentina.

DEUTSCHEN RÖNTGEN-GESELLSCHAFT

The thirty-fourth Congress of the Deutschen Röntgen-Gesellschaft will be held from April 28 to April 30, 1952, in the Kurhaus at Wiesbaden. The Chairman of the Congress is Dr. Gerhard Hammer, Städt. Krankenanstalten, Strahleninstitut, Nürnberg, Flurstrasse 17, Germany.

The following program has been arranged:

First Day—Diagnosis

Roentgen diagnosis of Bone Changes in Diseases of the Blood.

Radioactive Isotopes in Diagnosis.

Second Day—Therapy

Radiation Therapy of Diseases of the Hemopoietic System including the Reticuloses.

Third Day—Physics and Technique.

Radiobiologic Investigations on Radiation Protection.

Enlarged Roentgenograms with the Fine Focus Tube.

FOURTH INTER-AMERICAN CONGRESS OF RADIOLOGY

At the third Inter-American Congress of Radiology the Sociedad Mexicana de Radiología was elected to make the arrangements for the Fourth Inter-American Congress of Radiology to be held from November 2 to 8, 1952, in Mexico City, Mexico, D. F.

The following Committee of Arrangements was chosen by the Sociedad Mexicana de Radiología:

President—Dr. Manuel F. Madrazo
General Secretary—Dr. Guido Torres Martínez
General Secretary for Latin America—Dr. Narno Dorbecker C.
General Secretary for the United States and Canada—Dr. Guillermo Santín
Treasurer—Dr. Baudelio Villanueva

Correspondence concerning the Congress should be addressed to the General Secretary of the Sociedad Mexicana de Radiología, Dr. José Araujo G., Marsella No. 11, Mexico, D. F.

INDIAN RADIOLOGICAL ASSOCIATION

At a meeting of the Indian Radiological Association Dr. S. N. Deboo, M.B.B.S., M.R.C.S., L.C.P.S., Coronation Building, Gunbow Street, Fort, Bombay, was elected President for the year 1952. The Annual Congress was held in Bombay, February 8 to 11, 1952.

KENTUCKY RADIOLOGICAL SOCIETY

At the January meeting of the Kentucky Radiological Society, the following officers were elected for 1952: *President*, Dr. E. Lee Shiflett, Louisville, Ky.; *Vice-President*, Dr. James Rich, Lexington, Ky.; *Secretary-Treasurer*, Dr. Everett L. Pirkey, Louisville, Ky. Dr. Sydney E. Johnson, Louisville, Ky., was elected *Counselor of the American College of Radiology*.

ST. LOUIS SOCIETY OF RADIOLOGISTS

At a recent meeting of the St. Louis Society of Radiologists the following officers were elected for the year 1952; *President*, Dr. Hyman R. Senturia; *Vice-President*, Dr. Donald S. Bottom; *Secretary-Treasurer*, Francis O. Trotter, Jr.

WASHINGTON STATE RADIOLOGICAL SOCIETY

The officers of the Washington State Radiological Society for the year 1951–

1952 are as follows: *President*, Dr. Homer V. Hartzell; *Vice-President*, Dr. John W. Settle, Jr.; *Secretary-Treasurer*, Dr. John N. Burkey. The meetings are held on the fourth Monday of each month from September through May.

CONFERENCE OF THE INTERNATIONAL UNION AGAINST TUBERCULOSIS

The twelfth Conference of the International Union against Tuberculosis will be held in Rio de Janeiro, Brazil, August 24 to 27, 1952. Professor Manoel de Abreu of Rio de Janeiro, President of the Union, will preside at the conference, the first since that held in Copenhagen in 1950. The scientific sessions will be preceded by meetings of the Union's executive committee and council. Dr. J. Burns Amberson, visiting physician in charge of the chest service of Bellevue Hospital, New York, will give one of three scientific papers at the conference. He will present the principal report on "Treatment and Prognosis in Minimal Pulmonary Tuberculosis." Other papers will be on "Immunity and Tuberculosis," with Professor Arvid Wallgren of Sweden as the principal speaker, and "Organization and Results in regard to the Tuberculosis Campaign of Mass Surveys," with Dr. Fernando Gomez of Uruguay as the chief reporter. The Secretary General of the Union is Professor Etienne Bernard of Paris. Further information concerning the conference may be obtained from the National Tuberculosis Association, 1790 Broadway, New York, 19, New York.

ANNOUNCEMENT OF MEETINGS IN HOUSTON, TEXAS

Several meetings of interest to scientists and physicians will be held at the Texas Medical Center, Houston, Texas, on April 25 and 26, 1952.

These will include the *Sixth Annual Symposium on Fundamental Cancer Research* of The University of Texas M. D. Anderson Hospital for Cancer Research. One-half day will be devoted to selected papers on the subject of nutritional factors in cancer. *The Cancer Pathology and Radiology Conference* of The University of Texas M. D. Anderson Hospital and Postgraduate School of Medicine will be on *Tumors and Other Diseases of Bone*. A meeting of the *South Central Section* of the *College of American Pathologists* will coparticipate in the Symposium and Pathology Conference. There will be papers of general interest to pathologists. Dr. M. M. Wintrobe, Professor of Medicine at the University of Utah is arranging the session on nutritional factors in cancer. Dr. Granville Bennett, Professor of Pathology of the University of Illinois, and Dr. L. Henry Garland, Professor of Radiology at Stanford University Medical School, will jointly conduct the conference on *Tumors and Other Diseases of Bone*.

The third Bertner Foundation Lecture and Award will be made at the banquet on April 25, 1952. All meetings will be held at The Shamrock. Further information may be obtained from William O. Russell, M.D., at 2310 Baldwin Street, Houston 6, Texas.

JOSEPH FREEDMAN LECTURES

On Saturday and Sunday, April 26 and 27, 1952, Dr. David G. Pugh, Associate, Section of Roentgenology of the Mayo Clinic, and Assistant Professor of Roentgenology, University of Minnesota, will deliver the fourth annual Joseph Freedman Lectures in Diagnostic Roentgenology at the University of Cincinnati College of Medicine. Roentgenologists desiring to attend are requested to write Dr. Benjamin Felson, X-ray Department, Cincinnati General Hospital, Cincinnati, Ohio, for further details.

COURSE IN ESSENTIAL PHYSICS IN RADIOLOGY

The University of Southern California Medical Extension Education is presenting a course in the Essential Physics in Radiology to be given from March 10, 1952, to May 26, 1952, covering roentgen rays, radium, and isotope radiation, and clinical applications of isotopes. This course will

be offered every Monday evening from 8 to 10 P.M; the first six lectures to be presented at the Los Angeles County Hospital and the last six at the Cedars of Lebanon Hospital. Information concerning the course may be obtained from the Director, Medical Extension Education, University of Southern California School of Medicine, 1200 North State Street, Box 158, Los Angeles 33, California.

TECHNIQUES OF USING RADIOISOTOPES IN RESEARCH

Three additional courses in the techniques of using radioisotopes in research will be offered by the Special Training Division of the Oak Ridge Institute of Nuclear Studies this summer. Dates for the courses are:

June 9 to July 4, 1952
July 7 to August 1, 1952
August 11 to September 5, 1952

The courses are designed to acquaint mature research workers with the safe and efficient use of radioisotopes in research. Each course is open to 32 participants.

Application blanks and additional information may be obtained from Ralph T. Overman, Chairman, Special Training Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tennessee.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

Roentgenologic Diagnosis of Diseases of Bones. By David G. Pugh, Assistant Professor of Radiology, Mayo Foundation, Graduate School, University of Minnesota; Consultant, Section on Roentgenology, the Mayo Clinic. Cloth. Pp. 316, with 307 illustrations. Thomas Nelson & Sons, 19 East 47th Street, New York, New York, 1950, 1951.

This book consists of the section on diseases of bones recently published as the Fourth Issue of renewal pages of Diagnostic Roentgenology, edited by Ross Golden, M.D. It is now issued in separate book form.

While the descriptions of the diseases of bone are necessarily brief, the author has succeeded in giving concise but nevertheless adequate information concerning the individual disease conditions. It is his hope expressed in the introduction that they will be used as a basis for further investigation. Very few diseases are omitted and, where pertinent, the latest conception of the disease process is described. Controversial points are briefly touched upon but with sufficient emphasis to inspire further study of the literature.

The book is of easily readable size, the illustrations are satisfactory and the style lends itself to no confusion or interruption of the reader's train of thought. One of the means by which this is attained is the general lack of direct reference to investigators in the various fields. The sequence of the diseases in the table of contents is logically and well arranged. Throughout, the pathologic changes and alterations in physiology are emphasized. The bibliography is ample.

This is an excellent reference book and cannot be too highly recommended for inclusion in the library of every radiologist.

R. S. Bromer, M.D.

Coxitis tuberkulosa. Ein Beitrag zur röntgenologischen Pathologie der Skelettuberkulose. Sonderbände zur Strahlentherapie, Band 26. Von Dozent Dr. Herbert Gardemin, Chefarzt der Orthopädischen Abteilung des Evangelischen Waldkrankenhauses, Berlin-Spandau. Paper. Price, geh. DM 15.-, geb. DM 18.-. Pp. 166, with 245 illustrations. Urban & Schwarzenberg, Berlin-Charlottenberg, Branitzer Platz 5, Germany, 1950.

This is a monograph of 166 pages on tuberculosis of the hip joint. Following a general discussion of the roentgen changes in this disease, the author details the findings according to the location of the initial focus. Numerous roentgenograms and drawings together with short case summaries illustrate the appearance and method of progression when the disease begins in the epiphysis, in the neck of the femur, along the cortical margin of the neck, in the acetabulum, in the trochanter and in the capsule. A section is given over to the roentgen pathology of tuberculosis of the hip and includes (1) the roentgen pathology of the early stage, (2) the stage of progression, (3) the stage of reparation and (4) the end results of the disease.

The illustrations are of good quality, the printing is easy to read and the paper of good stock. This monograph is an excellent review of the subject and covers in detail the many phases of tuberculous coxitis. A bibliography—mostly references to the German literature—is appended.

L. W. Paul, M. D.

Røntgenundersøkelser ved akutte abdominalsykdommer. En laerebok. Av. J. Frimann-Dahl, Overlege dr. med Ullevål Sykehus, Oslo. Paper. Price, 22.-. Pp. 280, with 219 illustrations. Johan Grundt Tanum, Oslo, Norway, 1942.

This is a textbook on the roentgen appearance of the abdomen in acute abdominal syndromes. Most of the emphasis is placed on roentgenologic examination done without contrast media.

The text is divided into four parts. Part 1 contains a short description of the technique used and the type of apparatus necessary. The conclusion is that nothing special in the way of apparatus is necessary except a good Bucky diaphragm, or for portable cases, a good grid. In Part 2 the normal appearance of the

abdomen in its variations anatomically are described not only in the conventional supine position, but in upright, lateral decubitus, prone and lateral horizontal projections. In Part 3 a detailed account is given of the various changes which occur in the abdomen, such as the production and absorption of bowel gas, the finding of pneumoperitoneum and the appearance of free abdominal fluid in the various parts of the abdominal cavity. A fairly definite idea as to the amounts of free fluid present can be gauged by the intrinsic appearance of these fluid shadows. Pathologic conditions in the thorax may produce abdominal signs and symptoms, and these are discussed in general. In Part 4 definite pathologic entities are discussed in detail; descriptions are given of their appearance on the plain films of the abdomen for the most part, but also when contrast material is used.

Most of the statistics in the book come from the author's own experience at Ullevål Hospital. The volume contains 219 excellent roentgenographic reproductions.

Apart from the detailed description of the roentgenologic findings, the reviewer was impressed with the importance of roentgen examinations in the work-up of patients with acute abdominal symptoms. Evidently, an order for a roentgenologic examination of the abdomen at Ullevål Hospital does not mean that the clinician has ordered the roentgen department to take a kidney-ureter-bladder film.

An English translation of this book would make a notable addition to our list of standard textbooks.

Magnus I. Smedal, M.D.

Principles and Practice of Surgery. By Jacob K. Berman. A.B., M.D., F.A.C.S., Associate Professor of Surgery, Indiana University School of Medicine; Associate Professor of Oral Surgery, Indiana University School of Dentistry; etc. Cloth. Price, $15.00. Pp. 1,378, with 429 illustrations. C. V. Mosby Company, 3207 Washington Boulevard, St. Louis, Missouri, 1950.

The statement has occasionally been made by eminent teachers that no longer is it possible for any one individual to write a textbook of surgery. The "Principles and Practice of Surgery" by Jacob K. Berman challenges this view since the author has produced a very comprehensive yet readable volume which covers the field of surgery adequately and one which stresses throughout the fundamental aspects of and the scientific basis for the practice of surgery.

The book begins with a brief review of the history of medicine with particular emphasis on surgery. This is followed by a section devoted to general and clinical pathology. For students who have had a course in general pathology much of the material in this domain is repetitious. Included in the section on clinical pathology are tables giving normal values for the more commonly used laboratory tests. The section which follows consists of five chapters devoted to: (1) the human constitution, (2) interchange of body fluids, (3) acid-base balance, (4) hemorrhage, and (5) shock. These subjects are well presented and are given an amount of space commensurate with their importance. This section is particularly valuable since it epitomizes the material ordinarily presented in introductory courses in clinical surgery.

Much of the remainder of the book is concerned with regional surgery. The subject matter is arranged in broad general categories, *e.g.*, circulatory, respiratory, alimentary and nervous systems. The material is well covered, up-to-date and clearly presented. Topics of current interest, *e.g.*, aortic arch anomalies, vagus nerve section for the treatment of peptic ulcer and radioactive iodine in thyroid disorders, are included. While surgical technique is not featured, a sufficient description of many of the more common surgical operations is given to afford the reader an understanding of the rationale of the procedure and for comparative evaluation. The conventional order of a textbook of surgery has been altered. Fractures and dislocations are omitted except for a brief discussion of types and principles of treatment. This is in accord with the growing policy in medical schools and hospitals for the fracture service to be under the control of the Department of Orthopedics. Valuable space has been conserved by the elimination of chapters on diseases of the eye, ear, nose and throat. In many textbooks where these are included, they are covered in a cursory fashion inadequate for the courses in those specialties and redundant from the standpoint of a general surgical text. Urology and Gynecology are dealt with briefly in the final chapter.

The book is well edited, easily readable and authoritative. Throughout, the author clearly expresses his own opinions when controversial matters are involved. It represents the fruits of his own large experience and the personal element is felt in striking contrast with those books in which each chapter or section is delegated to a different author. The book should serve as a handy reference volume for house officers and practitioners while for medical students it bids fair to become one of the most widely used and recommended textbooks of surgery.

Henry K. Ransom, M.D.

Annual Review of Medicine. Windsor C. Cutting, Editor, Stanford University School of Medicine, and Henry W. Newman, Associate Editor, Stanford University School of Medicine. Volume I. Cloth. Price, $6.00. Pp. 484. Annual Reviews, Inc., Stanford, California, 1950.

The purpose of this and future projected volumes is to review annually the more active fields of medicine, and bi- or triennially other fields. In this first volume well-known authors selectively and concisely review the literature on a broad and interesting variety of topics under the following 21 headings. Infectious Diseases (July 1947–March 1949); Diseases of the Gastrointestinal Tract, Diseases of the Cardiovascular System (Surgical) (July 1947–July 1949), Diseases of the Cardiovascular System (Medical) (Jan. 1948–June 1949), Diseases of the Kidney (1946–1948 inc., and the early months of 1949), Nutrition in Medicine (Jan. 1948–July 1949), Allergy, Neoplastic Diseases, Diseases of the Reproductive System (Jan. 1947–Jan. 1949), Obstetrics (Sept. 1948–Sept. 1949), Diseases of the Nervous System (Neurology) (July 1948–Sept. 1949), Physical Agents and Trauma (Shock and Burns) (Jan. 1948–July 1949), Anesthesia (June 1948–June 1949), Radiology and Radioactivity (Radiobiology in the Services of Medicine) (Jan. 1947–July 1949), Diseases of the Ear, Nose and Throat (1938–1948), Hematology (Blood Formation and the Anemias), Laboratory Aid to Diagnosis and Therapy, and Therapeutics and Toxicology (Jan. 1948–Jan. 1950). The literature reviewed is cited at the conclusion of each section. A comprehensive Annotated List of Reviews in Medicine, published between July 1948 and November 1949, is included, the topic arrangement of which closely follows the chapter organization. These references are accompanied by brief notes as to whether they are clinical or of a more basic nature. A complete and detailed author and subject index concludes the book.

In reviewing their subject material the authors were asked "to make their scope broad and to include their own critical assessment of work discussed." They were "urged to pitch their writings at a scholarly level, to include experimental background and to avoid cookbook therapeutic recitals." Selective and critical reviews of this kind accomplish a real service when they succeed in broadening the horizon of the reader and afford him insight into the accomplishments obtained in fields perhaps alien to his own interests. In this respect it is evident that the goal of the Review, as defined, has been satisfactorily attained. Evaluation of the more specific function of the volume, as a source book of progress in specialized fields, is difficult. Much of the information in highly specialized fields will be satisfactorily appraised only by the readers particularly versed in these interests. In this regard the comments of the Editors are apropos: If the reader finds an interpretation to be biased " . . . a new author for the subject in a succeeding volume is as likely to stress another interpretation and thus in time the whole cycle of attitudes will be voiced."

From the standpoint of economy of time, ease of reading, and, indeed, completeness of information, the value of reviews of this type seemingly could be enhanced were the repetition of subject material kept at a minimum. Certain repetition is, of course, inevitable. Careful advance outline preparation, close cooperation by individual authors in subject organization and, finally, careful editing, would appear essential to this cause. The present volume suffers somewhat in this respect. Specifically, several authors independently discuss the chemotherapeutic agents, essential hypertension and its treatment, vitamin B_{12}, the artificial kidney, and arterial transfusions. Concentration of this information in specific sections would simplify the reader's task. Useful, in this respect, are carefully prepared summaries of subject material, as included in the section on Nutrition in Medicine. Their more general employment in other sections would be helpful.

Scientific literature is collected and published so swiftly these days that in some fields the

review is dated by the time it reaches the publishers, let alone the reader. Moreover, as R. R. Newell, author of the excellent section on Radiobiology in the Service of Medicine, comments, "What is both new and important is hard to select. What one fixes on as present day attainment may promptly be superseded. One would not care to predict how much of what one writes today will be worth reading tomorrow." The many authors and editors of the Review are to be congratulated upon their power of selectivity and successful minimization of these pitfalls. Nevertheless, the reader looking for recent specific information may be disappointed. This is, for example, true with regard to the physiological and therapeutic applications of ACTH and cortisone. The section dealing with advances in psychiatry is disappointingly brief, particularly in view of the fact that it covers a period of almost two years, for which only 21 references are listed.

The above are relatively minor criticisms of a project which is, on the whole, well accomplished. The Review will be of interest to specialists as well as general practitioners. The volume is the size of an ordinary textbook; that type size has been sacrificed to reduce bulk will be irritating to some. Interest in the forthcoming Volume II (1951) is created by including a list of its topics and authors. New sections are offered; the authors of repeated sections in this second volume will be new to the Review.

Ivan F. Duff, M.D.

Nutrition and Chemical Growth in Childhood. Volume III. Calculated Data. By Icie G. Macy, Ph.D., Sc.D., Director of the Research Laboratory, Children's Fund of Michigan, etc. With a Foreword by Helen A. Hunscher, Ph.D., Head of the Department of Home Economics, Western Reserve University, Cleveland, Ohio. Cloth. Price, $8.00. Pp. 712, with 733 tables. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1951.

This volume is the third of a series dealing with the nutrition and chemical growth in childhood by Icie G. Macy, Director of the Research Laboratory of the Children's Fund of Michigan. The first volume of the series deals with evaluation and is concerned with the methods and techniques employed and presents the average data for children. The second volume includes all data relating to the chemical analysis of food, urine and feces for consecutive balance periods over months for the same group of children and at different age levels. In addition, information is given relating to anthropometric measurements, blood chemistry determinations, roentgenographic studies, medical, dental and psychometric evaluations, and basal metabolic rate determinations.

The present volume, designated "Calculated Data," represents a collection of material which, in the opinion of the author, provides information of the greatest possible use and interest. It includes intakes, absorptions, and retentions for each child studied and presents the average values from the standpoint of age, body weight, body length, body surface, intake per day, and per kilogram of body weight per day.

The reviewer cannot refrain from complimenting the author and director of the research project, and the Children's Fund of Michigan, for the collection of a large amount of important facts based upon a long period of laborious and meticulous work, involving an incalcuable number of intricate chemical determinations. The book consists almost entirely of tables which bear on practically every phase of the chemical growth of children, and should be invaluable to every research worker in this field and those whose primary interest is in the nutrition and the growth of children. It should be in every medical library, and available to every research worker, but is not intended for the student or the practicing physician.

Cyrus C. Sturgis, M.D.

The Preparation of Photographic Prints for Medical Publication. By Stanley J. McComb, F.B.P.A., Section on Photography, Mayo Clinic, Rochester, Minnesota. Fabrikoid. Price, $2.00. Pp. 69, with 21 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1950.

One of the many problems arising in the preparation of a manuscript for publication is that of making or procuring suitable photographic illustrations. Whether photographs are adequate for the purpose or not depends to a great extent on the technical skill of the photographer. Proper arrangement of the object to be photographed, the selection and use of the correct kind of negative material,

careful exposure and processing of the film and print contribute extensively to the final result.

The photographer's responsibility in the preparation of medical illustrations is ably described by a leading medical photographer in this monograph. It is the work of Stanley J. McComb of the Mayo Clinic, whose experience well qualifies him as an expert on the subject. The various chapters in the monograph clearly explain how to avoid various pitfalls in the production of illustrations. The importance of proper sharpness of focus is given first place, since many photographic illustrations are poor because of fuzzy, unsharp images. The adoption of standard positions and scale sizes lends uniformity to the image. The proper employment of uniformly lit backgrounds helps greatly to emphasize the area of primary interest. When a photograph contains many distracting shadows and objects in the background, its usefulness is greatly decreased. Proper lighting of the object does much to indicate to the observer the details that are being described. Too often an author describes the appearance of a condition at considerable length, yet the reader finds in the illustration little visible evidence of what the author is writing about. Frequently, a large area of the subject is photographed, yet only a small portion is of primary importance. Concentration of interest should be secured by limiting the picture to the area of interest. If the photograph covers too much territory, it should be cropped so that the area of interest only is reproduced.

Many other excellent pointers regarding the mechanics of medical photography and the use of photographic illustrations for publication make McComb's book of value to the medical author.

Arthur W. Fuchs

BOOKS RECEIVED

Confrontations—Radio-Anatomo-Cliniques. Published under the direction of M. Chiray, R. A. Gutmann, and J. Sénèque. Volume IV. Paper. Price, 1250 fr. Pp. 65, with 127 illustrations. G. Doin & Cie.; Masson & Cie., 120, boulevard Saint-Germain, Paris 6e, France, 1951.

Visceral Radiology. By Emerik Markovits, M.D., Formerly, Scientific Collaborator of the Central Radiologic Institute of the General Hospital (Holzknecht-Institute), Vienna; Head of the Radiologic Department of Elizabeth Hospital of the City of Budapest; Post-graduate Lecturer at the Central Radiologic Institute of the University of Budapest; Radiologist of the Steiner Cancer Clinic, Atlanta, Ga. Cloth. Price, $24.00. Pp. 612, with 682 illustrations. The Macmillan Company, 60 Fifth Avenue, New York 11, New York, 1951.

Abdominal Distension and Intestinal Activity Following Laparotomy. A study of the "post-operative abdomen," especially the roentgenological findings after herniotomy, appendectomy and gynecological operations. *Acta radiologica*, Supplementum LXXXIII. By Andreas Høyer. Paper. Price, Sw. Crs. 15:-. Pp. 207, with 35 illustrations and 55 tables. Nationaltrykkeriet, Oslo, Norway, 1950.

Roentgen Manifestations of Pancreatic Disease. By Maxwell Herbert Poppel, M.D., F.A.C.R., Associate Professor of Clinical Radiology, New York University-Bellevue Medical Center; Associate Roentgenologist, New York University Hospital; etc. Cloth. Price, $10.50. Pp. 389, with 166 illustrations and 14 tables. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1951.

A Study in Slipped Upper Femoral Epiphysis. With Special Reference to the Late Functional and Roentgenological Results and to the Value of Closed Reduction. *Acta orthopaedica Scandinavica*, Supplementum No. VI. By Torsten Jerre. Paper. Pp. 157, with 30 illustrations. Ejnar Munksgaard, Copenhagen, Denmark, 1950.

Post-Graduate Lectures on Orthopedic Diagnosis and Indications. By Arthur Steindler, M.D., F.A.C.S., Professor of Orthopedic Surgery, State University of Iowa, Iowa City, Iowa. Volume II. Section A: Paralytic Disabilities. Section B: Static Disabilities. Cloth. Price, $6.00. Pp. 198, with 140 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1951.

Radiologia Austriaca. Herausgegeben von der Österreichischen Röntgen-Gesellschaft. Band IV. Cardboard. Price, $6.00. Pp. 207, with numerous illustrations. Urban & Schwarzenberg, Wien IX/71, Frankgasse 4, 1951.

Einführung in die Röntgenphotographie. Von Dr. Dr. Ing. e.h. John Eggert, O. Professor an der eidg. techn. Hochschule, Zürich. Unter Mitwirkung des Röntgen-Institutes am Kantonsspital, Zürich. Direktor: Dr. H. R. Schinz, O. Professor an der Universität Zürich. Siebente Auflage. Paper. Price, Fr. 20.-. Pp. 236, with 65 illustrations. S. Hirzel Verlag, Claridenhof, Gotthardstrasse 6, Zürich 2, Switzerland, 1951.

Tumors of the Mediastinum. Atlas of Tumor Pathology. Section V—Fascicle 18. By Hans

George Schlumberger, M.D., Professor of Pathology, Ohio State University, College of Medicine, Columbus, Ohio. Paper. Price, $.75. Pp. 88, with 75 illustrations. Published by the Armed Forces Institute of Pathology under the Auspices of the Subcommittee on Oncology of the Committee on Pathology of the National Research Council, Washington, D. C., 1951. For sale by the American Registry of Pathology, Armed Forces Institute of Pathology, Washington, 25, D. C.

Pathology of the Fetus and the Newborn. By Edith L. Potter, M.D., Ph.D., Associate Professor of Pathology, Department of Obstetrics and Gynecology, The University of Chicago; Pathologist, The Chicago Lying-in Hospital; Chief Pathologist, the Chicago Department of Health. Cloth. Price. $19.00. Pp. 574, with 601 illustrations. The Year Book Publishers, Inc., 200 East Illinois Street, Chicago 11, Illinois, 1952.

Gynecologic Cancer. By James A. Corscaden, Ph.B., M.D., Professor Emeritus of Clinical Gynecology, College of Physicians and Surgeons, Columbia University; Attending Gynecologist, Sloane Hospital for Women, New York. Cloth. Price, $6.00. Pp. 368, with 110 illustrations. Thomas Nelson & Sons, 19 East 47th Street, New York, New York, 1951.

A Manual of Artificial Radioisotope Therapy. Edited by Paul F. Hahn, Cancer Research Laboratories, Meharry Medical College, Nashville, Tennessee. Cloth. Price $6.80. Pp. 310 with numerous illustrations. Academic Press Inc., Publishers, 125 East 23rd Street, New York 10, New York, 1951.

Diathermy. The Use of High Frequency Currents. By Stafford L. Osborne, B.P.E., M.S., Ph.D., Professor and Chairman, Department of Physical Medicine, Northwestern University Medical School. Fabrikoid. Price, $3.00. Pp. 113, with 63 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1950.

Committee on Growth of the National Research Council. Fifth Annual Report to the American Cancer Society, Inc. Paper. Pp. 376. American Cancer Society, Inc., 47 Beaver Street, New York 4, New York, July 1949–June 1950.

ABSTRACTS OF RADIOLOGICAL LITERATURE

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ROENTGEN DIAGNOSIS

Head

Piaggio Blanco, Raúl A., Ramírez, Fortunato, and Ferrari Forcade, A. Platibasia y trastornos neurológicos del tipo siringomiélico. (Platybasia and neurologic disturbances of the syringomyelic type.) *An. Fac. de med. de Montevideo*, Sept., 1950, *35*, 1207–1213.

Platybasia signifies an osseous defect involving the occipital foramen and the first cervical vertebrae. There is flattening of the posterior cerebral fossa with a protrusion of the occipital foramen towards the interior of the cranium so that the clivus, which normally is oblique backwards and downwards, assumes a horizontal position. At the same time, the occipital foramen is usually deformed. The most common change in the cervical spine is the occipitalization of the atlas which may be complete or incomplete. In consequence of this change, the odontoid process of the axis lies at the inferior border or within the occipital foramen.

The authors describe the case of a thirty-five-year old man who, in addition to these reported bone changes, showed marked neurologic disturbances. The upper left extremity exhibited muscular atrophy especially in the small muscles of the hand of the Aran-Duchenne type. The reflexes were reduced; the bicipital reflex entirely abolished. In the regions innervated by the left sensory roots of C_5 C_6, C_7, C_8, D_1 and D_2, there existed a thermo. analgesia with preservation of the tactile and deep sensibility, that is, a syringomyelic dissociation of the sensibility. The cutaneo-abdominal reflexes were abolished. Disturbances of the sensibility in the areas innervated by the left roots of D_3 to D_{10} were also observed. In the lower extremities, there existed a spasmotic paraparesis, marked reflexes, clonus and bilateral Babinski. The roentgenographic examination of the skull and the vertebral column showed the clivus in horizontal position. The occipital bone in this area, instead of being normally concave upwards, was convex. Tendency of the atlas towards occipitalization was also present. The posterior arch of the atlas appeared in direct contact with the occipital bone and partly fused with it. The cervical spine was flexed and had lost its anterior convexity. Descending myelography by means of 3 cc. of lipiodol injected into the cisterna magna revealed the typical picture of diffuse arachnoiditis. Encephalography demonstrated a generalized dense symmetrical dilatation of the ventricular system. In contrast to these encephalographic findings, the electroencephalographic tracings showed normal cortical bioelectric activity. In the thoracic spine a loss of the normal dorsal kyphosis and a slight scoliosis towards the left were observed. There was no evidence of spina bifida or of a reduction in the number of the vertebrae, or of hemivertebrae or of vertebral fusion as observed in the Klippel-Feil syndrome. According to List, the neurologic symptoms associated with platybasia are due to the anterior dislocation of the occipitalized atlas and to developmental abnormalities (malformation of the Arnold-Chiari type, dystrophic syndromes, etc.). Hydrocephalus is supposed to be secondary to stenosis of the occipital foramen.

The clinical diagnosis of this disease is of more than theoretical interest since the neurologic changes of mechanic origin can be improved by surgical intervention. Benefit has been reported in cases in which the diagnosis of tumor of the posterior fossa was given and the surgical intervention showed a syndrome of platybasia with a malformation of the Arnold-Chiari type. Similar good results by decompression have been obtained in cases in which there was compression of the higher cervical medulla simulating syringomyelia, plaque-like sclerosis, lateral amyotrophic sclerosis or the like.

Due to the patient's refusal, no surgical intervention was attempted in the reported case.—*E. A. Schmidt, M.D.*

Falk, Bengt. Calcifications in the track of the needle following ventricular puncture. *Acta radiol.*, April, 1951, *35*, 304–308.

The complications following ventriculography which have been described to date are, on the one hand, bleeding and, on the other, increased intracranial pressure. However, in addition to these complications which may be immediately associated with ventriculography, there are injuries following the procedure which may be observed at a later stage. These may occur even if no complications were obvious at the time of the procedure. Calcifications at the site of track of the puncture needle have been found in the Department of Radiology of the Serafimer Hospital during the re-examination of patients who had previously been submitted to ventriculography. These calcifications are of two types. The one consists of deposits which run in the form of a string from the region of the burr-hole in the direction of one lateral ventricle. They thus follow the course of the puncture track. Sometimes the whole track is seen to be calcified and again only a part may be affected. The other type consists of calcifications lying inside and immediately below the burr-hole. These are situated just below the bone table and are more compact and irregular than the others.

The author has examined 203 patients from one month to fifteen years after ventriculography. He found calcifications in 27 cases, or 13.3 per cent. The earliest interval following ventriculography at which calcifications were found was six months.

It is recommended that encephalography rather than ventriculography be done in all cases.—*Mary Frances Vastine, M.D.*

Svien, Hendrik J., and Johnson, A. Beaumont, II. Fluroescein in the localization of brain tumors. *Proc. Staff Meet., Mayo Clin.*, April 11, 1951, *26*, 142–151.

In an effort to localize brain tumors by the use of radioactive diiodofluorescein and the Geiger counter, the authors have used the method and technique of Moore. (Moore, G. E. Use of radioactive diiodofluorescein in the diagnosis and localization of brain tumors. *Science*, 1948, *107*, 569–571.)

In the authors' experience the use of radioactive diodofluorescein in the localization of brain tumors is limited roughly to 50 per cent of the cases. In this group of tumors they have found that this method of localization gave results which are precise enough to be of use to the surgeon in almost 40 per cent of these cases.

They found, as did Moore, that tumors less than 3 cm. in diameter unaccompanied by a halo of edematous tissue were sometimes missed and that tumors of the posterior fossa and parasellar region were difficult to localize.—*J. J. McCort, M.D.*

Uihlein, Alfred. Cerebral angiography. *Proc. Staff Meet., Mayo Clin.*, April 11, 1951, *26*, 133–139.

One hundred cerebral angiograms were made on 77 patients by percutaneous injection of the common carotid artery. In 31 patients suspected of having a brain tumor, 16 lesions were identified by cerebral angiography (52 per cent). Seventeen of 36 patients suspected of having a subarachnoid hemorrhage demonstrated a vascular lesion by angiography (47 per cent). In 6 cases the angiograms did not indicate a brain tumor, the presence of which was later verified. In 2 cases, the angiograms were interpreted as indicating a brain tumor but the diagnosis could not be verified at operation. Unsatisfactory angiograms were obtained in 10 per cent of the cases owing to technical difficulties.—*J. J. McCort, M.D.*

Curtis, J. B. Cerebral angiography. *Brit. J. Surg.*, Jan., 1951, *38*, 295–331.

The author reviews his experience with over 700 carotid angiographic studies with particular reference to intracranial tumors and other space-occupying lesions. In addition, he presents 94 cases with normal angiograms which have been studied by the 3-film and/or rapid serial method, to gain a detailed knowledge of the appearance of the normal angiogram.

No consideration has been given here to vertebral angiography; the author has found that the percutaneous technique as used by Sugar, Holden and Powell is in most cases practicable, but further experience is required to estimate its value in diagnosis. The author believes that, with the carotid route, angiography has its greatest value in the diagnosis of tumors of the cerebral hemispheres, and especially with tumors of the anterior two-thirds of the hemisphere. Tumors of the posterior third of the cerebral hemisphere not only lie away from the main branches of the internal carotid, upon the displacement of which angiographic diagnosis so largely depends, but they are also frequently, in whole or in part, within the vascular zone supplied by the posterior cerebral artery.

Details are given of the angiographic appearances of different types of tumors in different locations. There are also certain general considerations which must be constantly borne in mind. Good roentgenograms are essential and to this end the technique of puncture, of injection, and of positioning requires constant practice by an unchanging team.

The interpretation of the roentgenograms should be carried out systematically. The first step is to determine whether the skull has been accurately positioned and the tube accurately centered, and, if the projection is not a true one, to make allowance for the resulting effect of parallax upon the position of the vascular images. It must be remembered that variations in the position of the central ray of the tube will affect the position of the bony landmarkings by which a true projection is judged.

The next step should be to study the roentgenogram made in the anteroposterior projection. The most important general sign produced by hemisphere tumors is a lateral displacement of the anterior cerebral artery from the middle line. This lateralizes the lesion. The normal deviations of the anterior cerebral artery to one side or other are never gross, and retain the normal curled appearance of the vessel; and they frequently involve both sides in different parts of their course. Normal variations are usually localized, whereas pathological displacement almost always involves the whole of the anterior cerebral artery lying below the falx, and the artery loses its coils and appears stretched.

According to the author, the shape of the displacement of the anterior cerebral artery is most valuable in localization and has received insufficient attention. Fischer noted the type occurring in frontal tumors and found it important. List and Hodges, and Wickbom describe the appearance produced in different tumors, but do not remark on its important localizing value. Egas Moniz and his colleagues appear to have placed little reliance on the anteroposterior projection. In the author's series it was found that if the artery is markedly curved the tumor is frontal, whereas if the artery is only slightly curved the tumor is frontoparietal. Occasionally this may be the only unequivocal localizing sign. If the displacement is straight, with an abrupt return to the middle line in its upper part, the tumor is either temporal, parietal, or occipital, and the precise diagnosis depends on the presence or absence of elevation of the middle cerebral artery and the other

signs already described. The only tumors which have shown no displacement of the anterior cerebral artery have been situated either in the basal ganglia, or in the parieto-occipital or posterior parasagittal areas, but some of these show a lateral displacement of the internal cerebral vein. It must be remembered that conditions other than tumors which produce a ventricular shift may also produce a shift of the anterior cerebral artery to or from the side of the lesion. These include subdural and extradural hematomas, cerebral atrophy, and scarring. Bifrontal tumors, as might be expected, frequently produce a minimal lateral shift.

The next step is to study the roentgenogram made in the lateral projection. The most important sign in the lateral projection is displacement of the sylvian group of vessels. Upward displacement indicates a tumor of the temporal lobe or middle fossa. It is distinguished from the normal by the fact that all the vessels in the sylvian fissure are displaced together, and they tend to have an arched stretched course. If the tumor is deep, such as a cavernous sinus meningioma, it lies near the proximal part of the middle cerebral artery and the terminal intradural part of the internal carotid artery. Then these parts are elevated and stretched and the siphon is opened. However, tumors lying low in the middle fossa may produce no obvious changes; in such cases, a pneumographic study of the temporal horns may prove much more valuable.

Apparent depression of the sylvian group has no significance unless it involves all the vessels lying in the fissure and these appear stretched. The interpretation can be checked from the fact that tumors which depress the middle cerebral artery also cause a characteristic shift of the anterior cerebral artery in the anteroposterior projection.

In certain regions the diagnosis may depend on minor changes in large vessels; for example, in the suprasellar and posterior parasagittal regions. In general, minor changes in one projection should be confirmed by changes in the other projection; otherwise pneumoencephalography should be employed.

A pathological circulation helps in localization. In the author's series it was demonstrated in 75 per cent of meningiomas, in 75 per cent of the glioblastomas, and in less than 2 per cent of astrocytomas. It has been seen in rapid serial angiograms in cases in which it was not shown by the 3-film method. It is important not to overlook signs which indicate that the tumor extends farther than the pathological circulation indicates.

The phlebograms have their greatest value in showing pathological circulation. Little reliance can be placed on the position of the normal surface veins, including the superior and inferior anastomotic veins, owing to their inconstant site and appearance; but normal veins pursue a slightly wavy course and if this is lost and the vein runs in a large stretched curve a tumor should be suspected.

The appearance of the internal cerebral vein is often of great value in diagnosis as it runs a constant course in the roof of the third ventricle. At its anterior end it curls back and this accurately marks the site of the foramen of Monro. Hydrocephalus involving the third ventricle causes the internal cerebral vein to be arched upwards and backwards. Tumors invading the third ventricle, such as suprasellar pituitary tumors, may also elevate it. Frontal tumors generally displace the site of the foramen of Monro backwards. Lateral displacement of the internal cerebral vein should always be looked for in the anteroposterior phlebogram as it is of great lateralizing value if present, particularly if there is no shift of the anterior cerebral artery.

Frontal, rolandic and temporal tumors are localized accurately in a high percentage of cases. Parietal tumors are much more difficult, particularly if they are deep; some in the author's series have not shown the features described by Wickbom.

From the point of view of vascularization intracranial tumors of the hemispheres fall roughly into two types—the vascular and the avascular. If a tumor is vascular it may be a glioblastoma multiforme, a meningioma, a metastatic tumor, or one of the rare types of astrocytoma with abnormal vessels. The differential diagnosis depends on the type of pathological vessels, is described in the previous section. If a tumor is avascular it is most commonly an astrocytoma, but it may be a necrotic or cystic glioblastoma multiforme, a meningioma, a metastatic tumor, or an abscess. Avascular meningiomas may show characteristic features of vascular displacement which have been described. Avascular metastatic tumors have no special characteristics, except that they are generally small and may be multiple. The preoperative diagnosis of an abscess rests almost entirely on clinical grounds, but may be assisted by angiography.

In conclusion, the author states that the interpretation of cerebral angiograms is still far from perfect, and it is to be anticipated that much greater precision will be attained with increasing experience, especially in recognizing finer changes in the less easily demonstrated vessels, as for example the internal cerebral vein. In this connection the educational value of rapid serial angiograms is worthy of consideration.

This is an excellent article richly illustrated with carotid angiographic reproductions and diagrams.—*R. F. Niehaus, M.D.*

Störtebecker, Tore Patrick. Metastatic hypernephroma of the brain from a neurosurgical point of view; report of 19 cases. *J. Neurosurg.*, March, 1951, *8*, 185–197.

The author discusses the advisability of operating upon a patient with metastatic hypernephroma of the brain after analyzing 19 cases which occurred at the Neurosurgical Clinic of Serafimerlasarettet in

Stockholm. These cases represented 13.4 per cent of all the metastatic brain tumors. Seventeen of the 19 cases were operated upon.

Since most metastases to the brain from hypernephroma are solitary, the author feels that extirpation of the metastasis is worth while. The symptoms do not differ materially from those of primary cerebral tumors. If the lesion is solitary and satisfactorily located, the surgical removal is not difficult as the tumors are usually enucleated easily.

Patients may live several years and in 1 case the patient is still alive after fourteen years.

The removal in many cases will relieve the headache. There is usually an improvement in the general health and in a few instances the patient may return to an active life. In some cases the vision has been impaired permanently, especially when the disc choking was severe preoperatively.

The prognosis is most favorable in those cases in which the primary tumor had been removed by nephrectomy before the symptoms of brain metastasis became manifest.—*Norman Heilbrun, M.D.*

Scoville, William Beecher, and Sherman, Irving Jerrold. Platybasia; report of ten cases with comments on familial tendency, a special diagnostic sign, and the end results of operation. *Ann. Surg.*, April, 1951, *133*, 496–502.

Platybasia, also referred to as basilar impression or invagination, is easily diagnosed by roentgen ray, yet often missed simply because it is not looked for. Clinically, platybasia may simulate multiple sclerosis, syringomyelia, other degenerative cord diseases, and hydrocephalus. A fundamental feature of platybasia is the deformity of the foramen magnum and the invagination of the cervical spine into the cranial cavity, so much so that occasionally the first cervical vertebra is hidden within the foramen magnum. In the majority of cases, this is associated with other congenital anomalies of the skeleton and brain stem, especially an Arnold-Chiari deformity. Occasionally, cases of platybasia have followed Paget's disease or osteogenesis imperfecta.

Compression of the contents of the posterior fossa with angulation of the medulla over the intruding odontoid process produces nystagmus, staggering gait and sensory loss, which is often associated with pyramidal tract signs. The adhesions about the herniated cerebellar tonsils may cause hydrocephalus. Patients usually exhibit a short, squat neck with backward tilting of the head. Diagnosis is confirmed roentgenographically both by a distorted, narrow foramen magnum in the basal view and by the elevation of the odontoid process above Chamberlain's line, in the lateral view although this may occur to a slight degree in 5 per cent of normal patients. The atlas is generally fused to the occiput, as shown by a roentgenogram in the flexed position, and may even be hidden within the foramen magnum. An accompanying Arnold-Chiari deformity may be diagnosed by myelography.

The only known effective treatment is surgical decompression of the foramen magnum and the upper cervical spine. Surgical decompression in this series of 10 cases arrested progression but only in 3 cases was there improvement in the neurological disability. Operation should be performed early in cases showing progression, but it is of doubtful value in stationary cases. The authors report a familial tendency to the deformity.—*E. A. Addington, M.D.*

Clarke, B. Earl, and Parsons, Herbert. An embryological tumor of retinal anlage involving the skull. *Cancer*, Jan., 1951, *4*, 78–85.

This is a case report of an unusual tumor in a nine month old white boy attached to the soft tissues of the anterior fontanelle and growing rapidly in four months to involve the adjacent bone. Surgical resection of the tumor along with a portion of the sagittal sinus and tributary cerebral veins was achieved without demonstrable neurological deficit.

Roentgenographically the tumor appeared to spread the anterior fontanelle and produce new periosteal bone in a radiating sunburst pattern from the central soft tissue mass and from the inner and outer cranial tables without evidence of bone destruction.

On gross examination, the tumor was firm with a bluish-white cut surface, measured 7.5 by 5 cm. and was surrounded by a rim of cranial bone. Microscopically, it presented the picture of an embryological tumor with two types of cells, neuroblasts and pigmented epithelial cells attempting to form retinal tissues at about the five to six week embryonic stage. Consideration was made and discounted of the possibility of a phylogenetic tumor, similar to the medial or pineal eye such as seen in lower vertebrates (lampreys).

Since 1947 one other case of "maxillary tumor of retinal anlage" has been reported similar to the authors' case (anterior fontanelle calvarium site) believed to be the second report in the medical literature. The suggestion is made that this type of retinal anlage tumor should be designated as pigmented retinoblastoma.—*E. H. Price, M.D.*

Martin, Hayes, and Foote, Frank W., Jr. A third case of so-called retinal anlage tumor. *Cancer*, Jan., 1951, *4*, 86–91.

This is a third case report of an unusual tumor in the right maxilla of a four month old white girl. Extensive surgical resection was performed with surprising minimal deformity of face or intraoral areas as determined on the last (six years) postoperative examination.

Roentgenograms showed extensive destruction of

the anterior portion of the alveolar process of the right superior maxilla extending up into the adjacent hard palate, but not involving the corresponding antrum. Roentgenological bone and chest surveys, otherwise, were not remarkable. The removed tumor measured 2 by 2 cm., was solid, and on cut surface showed only a small amount of white tissue with 90 per cent of the bulk composed of bluish-gray to black pigmented areas. Microscopically, three constituent types were noted: pigmented cells, neurocytes and spindle cells. Many areas of the tumor bore resemblance to malignant forms of neuroblastoma, but clinical course after six years suggests benignancy.—*E. H. Price, M.D.*

Schroeder, A. H., Medoc, J., and Schroeder Otero, A. M. Glioastrocitomas quisticos del cerebelo en el niño. (Cystic glioastrocytomas of the cerebellum in the child.) *An. Fac. de med. de. Montevideo*, 1951, *36*, 77–108.

The authors describe in detail 5 children with cystic glioastrocytoma of the cerebellum, observed and operated upon, whose extirpated tumors were studied histologically. In Montevideo 5 cases constitute an appreciable number of patients with this lesion, as Penfield and Cone were able to cite only 14 cases, of whom 6 were children. The 5 cases reported here all recovered completely, and are well, some of them six years after operation.

All of their cases presented intracranial hypertension and localizing symptoms. The hypertension appeared clinically from one month to four years before examination by the authors, cephalalgia being the most common and constant complaint, with or without the accompaniment of vomiting. One case began with vertigo. Roentgen findings were lacking in only 1 case. All the other cases presented abnormal digital impressions or diastasis of the cranial bones, enlargement of the subtentorial fossa, a large head, or alterations in the sella turcica of the type seen with endocranial hypertension. The localizing symptoms were dysmetria and intentional tremor in 4 cases; hypertonia in 3 cases, adiadochokinesia in 2, nystagmus in 2, and static and ambulatory disturbances in 3 cases. One case showed difficulty in raising the eyes and 2 exhibited psychic symptoms.

Electroencephalography was used in 1 case, indicating localization of the lesion in the right occipital region. Ventriculography has problems in these cases which have not yet been resolved, so the ideal would be to depend on encephalography supplemented by arteriography and when necessary also by ventriculography. Arteriography, to be useful in subtentorial localizations, must be done via the vertebral artery, which is difficult, whether the artery is exposed or the injection is made by transcutaneous route. The surest method for localization of subtentorial neoplasms is still ventriculography, which the authors practice with air. The examination is aimed at visualization of the third ventricle, which will eliminate a third ventricular tumor and show the existence of a subtentorial tumor. With the ventricles filled, and the patient's head placed face down, somewhat lower than the rest of the body, lateral roentgenograms are made. These at times show the fourth ventricle in its entirety, being either enlarged or displaced or partially occupied by tumor, and in some cases enabling a decision as to which hemisphere harbors the lesion.

On the basis of the clinical, etiological, operative, developmental and anatomopathological considerations, the authors believe that fibrocystic astrocytoma of the cerebellum is a neodysplasia, that is, the neoplastic evolution of a congenital gliovascular malformation. In its slow development it is exposed to great structural modifications which constitute this lesion as a disease entity particularly likely to be found in childhood and very probably in the cerebellum.—*J. T. Case, M.D.*

Donald, Dan C., Jr., Kesmodel, Karl F., Jr., Rollins, Stacy L., Jr., and Paddison, Richard M. An improved technic for percutaneous cerebral angiography. *Arch. Neurol. & Psychiat.*, April, 1951, *65*, 508–510.

The authors, realizing some of the disadvantages of the percutaneous method of carotid injection for cerebral angiography, have devised a catheter modification. A 15–17 gauge 3 inch Huber point needle of special design is used for arterial puncture. A small radiopaque catheter is then threaded through the needle and up the internal carotid artery under fluoroscopic control. The needle is withdrawn, and continuous slow injection of isotonic saline is employed through the catheter. Using a syringe system, 5 cc. of thorotrast or diodrast is injected as rapidly as possible, with the roentgenograms taken at the end of the injection.

The advantages are that no perivascular spill occurs; that there is less trauma to the intima of the artery; that no danger exists on moving the head; and that less dilution results since the catheter is above the external carotid.—*G. H. Ramsey, M.D.*

Whittier, John R., Deaths related to pneumoencephalography during a six year period. *Arch. Neurol. & Psychiat.*, April, 1951, *65*, 463–471.

The author reviews the circumstances attending fatalities from pneumoencephalography at the Neurological Institute of New York. Davidoff and Dyke had reported 9 fatalities in 4,000 cases, or 0.22 per cent. The author reports 24 deaths in 2,490 pneumoencephalographic studies. A relationship was considered to exist when deterioration in the clinical condition of the patient began shortly after the procedure and continued uninterrupted until death. Six cases fell in this category, while 18 were con-

sidered unrelated. A summary of the case histories of the 6 cases is given. The mortality rate of 0.22 per cent agrees with that indicated by Davidoff and Dyke. Large space occupying lesions were present in all cases. Death usually occurred between four and a half and ninety-seven hours. In 4 of the 6 cases increased intracranial pressure was present and in 3 it was demonstrated roentgenographically. Rarely are there any symptoms during the actual examination, although a rise in blood pressure is ominous.

The study confirms the danger of pneumoencephalography in patients with intracranial lesions. Whether the change in the anatomic relations of the intracranial structures interferes with the physiological function, even though only a small amount of air is substituted, or ischemia from vascular distortion and compression or some other physiological factor is the cause, is not stated. The conclusion is reached that some other method should be used in such cases. —*G. H. Ramsey, M D.*

CASAMAJOR, LOUIS, LAIDLOW, ROBERT W., and KOZINN, PHILIP J. The technique of pneumoencephalography in children; comparative results with air and oxygen injection. *J. Pediat.*, April, 1951, *38*, 463–467.

The authors had a series of pneumoencephalograms, 200 of which were performed with air as the contrast medium and the other 100 using oxygen as the medium. They found that the postoperative course of all cases was more stormy when morphine was used as a preliminary medication. The advantage of oxygen over air as a medium was shown by the following factors: less subsequent headaches, less vomiting, fewer rises in temperature, and quicker time of recovery without symptoms.

The technique of the authors includes: an enema the night before the examination and forcing of fluids until midnight, atropine and codeine as a preliminary medication, avertin anesthesia, and the encephalographic technique adovcated by Davidoff and Dyke. Films are developed at frequent intervals during the filling to guard against introduction of too much gas. The authors rarely inject more than 100 cc. of gas. An average of forty minutes is required for the entire procedure.—*R. M. Harvey, M.D.*

ECKER, ARTHUR, and RIEMENSCHNEIDER, PAUL. Deliberate thrombosis of intracranial arterial aneurism by partial occlusion of the carotid artery with arteriographic control; preliminary report of a case. *J. Neurosurg.*, May, 1951, *8*, 348–353.

Aneurysms of the intracranial arteries located below the circle of Willis have been best treated, in general, by carotid ligation. This is probably due to thrombosis within the aneuryism. The disadvantages of this form of treatment are occasional rupture of the aneurysm and cerebral anemia. The ideal therapy is enough impairment of arterial flow to produce thrombosis of the aneurysm alone, without causing either cerebral anemia or thrombosis of the parent artery.

The authors report a patient with a saccular aneurysm of the left internal carotid artery near its bifurcation which was treated by partial occlusion of the left common carotid artery for one week by a tantalum clip. Thrombosis of about 80 per cent of the aneurysm occurred. The aneurysm was visualized arteriographically. It was broad and not suitable for direct excision. Conservative treatment with bed rest and total compression of the left internal carotid artery failed to produce thrombosis of the aneurysm as determined by arteriograms. An arteriogram following the insertion of the tantalum clip revealed no evidence of residual aneurysm and no encroachment on the lumen of the internal carotid artery as it passed the aneurysm.

In order to determine whether carotid compression will produce stasis within the aneurysm, the aneurysm must be in a dependent position. Thirty-five per cent diodrast which has a greater specific gravity than blood will pool in the dependent aneurysmal fundus. Then carotid angiography with compression below the needle will give positive proof of stasis which is essential for the development of thrombosis.—*F. J. Rigos, M.D.*

GURDJIAN, E. S., and WEBSTER, J. E. Cerebrovascular accidents; surgical management with particular reference to massive intracranial hemorrhage. *Arch. Surg.*, May, 1951, *62*, 724–736.

The authors report 11 patients operated on by them who had large intracerebral collections of blood due to cerebrovascular disease. The youngest was twenty-one years of age and the oldest fifty-nine. They stress the value of cerebral angiography in the diagnosis and they do not hesitate to use this procedure within two days after the accident. Although 10 patients had angiograms, angiomatous lesions were located in only 2 cases. Angiographic findings may be misleading in supratentorial lesions in the posterior one-third of the head, and with these air studies have been more accurate in localizing the mass but supratentorial lesions in the more forward areas of the brain are well lateralized. They advise the use of 35 per cent diodrast although they consider thorotrast safe in older persons.

The pathologic lesion in many patients with massive intracranial hemorrhage is a semiliquid collection with necrotic brain lining the wall. It is usually located in the temporoparieto-occipital area. As an initial therapeutic step, a trephine opening above and posterior to the ear will permit the introduction of a blunt needle into the collection. It may be visualized by injecting diodrast or thorotrast into the cavity following aspiration or removal of the contents.

If no collection is found, or if the patient does not improve on repeated aspirations, a craniotomy is indicated. Collections which cause a ventricular shift are usually large and in many instances have been over 30 cc. in volume.

Operative intervention to excise the lesion which may cause a repetition of the bleeding is a question which has to be decided after thorough study of the individual case.—*A. E. Childe, M.D.*

Matthews, George W. Value of the occlusal roentgenogram in locating impacted mandibular third molars. *J. Am. Dent. A.*, May, 1951, *42*, 515–517.

The author, a dental surgeon, emphasizes the value of supplementary occlusal films for more accurate evaluation of mandibular third molar impaction. These films are so named because the central ray is directed from below perpendicular to the occlusal surfaces of the lower molar teeth. By this method, the author has been able to avoid sacrifice of some neighboring second molar teeth if they were in good functioning occlusion. Doubtless most radiologists share this belief in the value of the occlusal projection for third molar demonstration in addition to its other uses.—*J. W. Turner, M.D.*

Neilson, D. F. A. The vulnerability of the eustachian tube. *Proc. Roy. Soc. Med.*, April, 1951, *44*, 301–304.

This paper deals with the pathological factors which damage the eustachian tube and impair its function, the anatomical and other factors which enable it to resist such injury, and methods of treatment.

Pathological factors: 1. Occupation. Aviation and caisson work fundamentally involve the same occupational hazard to the eustachian tube, namely that of change of barometric pressure. A rapid change of barometric pressure may cause a severe relative lowering of the intratympanic pressure. This may cause pain, deafness and retraction of the tympanic membrane. It may be avoided by swallowing during the change of pressure. The act of swallowing causes the nasopharyngeal entrance of the tube to open and thus let air in or out as the occasion requires. The tube then at once returns to its state of passive closure.

2. Infection. Infection in the nasopharynx impairs the efficiency of the eustachian tube opening mechanism, thus allowing inequalities of barometric pressure on either side of the tympanic membrane. The tympanum may be infected by way of the tube.

Treatment: The treatment of enlarged and infected adenoids is essentially surgical. (The author reserves irradiation for the elimination of swollen and degenerated lymphoid tissue on the lateral wall of the nasopharynx. The technique of treatment is prescribed by the author's radiological consultant. The technique and factors are not considered here.)

The clinical techniques which constitute the oro-otolaryngologist's armamentarium of therapy are mentioned in brief.

Discussants.

Mr. H. S. Kandor: Children who have a second operation for recurrent adenoids may still have recurrent otitic attacks and persistent deafness. Mr. Kandor's results in these cases were excellent when deep roentgen therapy was used. According to the statements of mothers and teachers 90 per cent showed symptomatic improvement of deafness; 78 per cent showed measurable audiometric improvement. Some cases showed over 20 decibels improvement. There were no ill effects, but 2 cases exhibited transient parotitis following treatment.

Professor Paul Frenckner (Stockholm): (Professor Fenckner's remarks are essentially confined to surgical techniques and historical considerations.)

Fifteen years ago following total resection of the upper jaw for cancer, it was found that ciliary movements were totally abolished for years following application of radium. It might be the same if excessive roentgen and radium therapy were used in the nasopharynx.

Mr. F. M. Allchin (radiotherapist): Proper radiation doses do no permanent damage to the mucous membrane of the nasopharnyx. Treatment of children from seven to fifteen years of age during the past fifteen years failed to produce a case of permanent change. Sensitive cases, those in which nasal catarrh was a prominent symptom, and those with possible local infection might show severe primary reaction, but this subsides.

In adults roentgen therapy is used. Radium has been abandoned for the following reasons: Physical measurements of different types of radium applicators showed the intensity of radiation to fall off rapidly. Therefore, a series of doses were given in order to get rid of the excess lymphoid tissue. This proved harmful to the superficial surfaces of the mucous membrane and destroyed the ciliated epithelium. Permanent damage had been produced in the eustachian tube by use of radium applicators.—*D. R. Bernhardt, M.D.*

Goldman, Benjamin. Total excision of the scalp and portions of the face; restoration by skin grafting: the surgical management of massive cylindroma of the scalp and face. *Ann. Surg.*, April, 1951, *133*, 555–560.

The author states that this is the first instance of surgical removal of the entire scalp for "turban tumor" or cylindroma. The entire scalp was covered with large, reddish-colored, smooth pedunculated, grape-like masses varying from 1 cm. to 6 cm. in diameter. The lesion involved the forehead, both ears, the cheeks, the mastoid areas, and a portion of the neck, posteriorly. Smaller lesions were sepa-

rately removed from the auricles and external auditory canals as well as from the face, by use of the high frequency cutting current and electrodesiccation. The surgical excision was later followed by skin-grafting procedures which were successful. The author suggests that early treatment of future cases by electrodesiccation might eliminate scalp excision.

Color photographs dramatically indicated the extent of the lesion in the case reported as well as the final end results.—*C. N. Borman, M.D.*

Neck and Chest

Knott, J. M. S., and Christie, Ronald V. Radiological diagnosis of emphysema. *Lancet*, April 21, 1951, *1*, 881–883.

It has been claimed that emphysema presents characteristic roentgenological appearances, and the purpose of the investigation described here was to test this claim. The authors selected 20 patients, aged forty-five to sixty, with a clinical diagnosis of moderate or severe emphysema. As a control, 20 patients of the same age group were selected in whom there was no evidence of respiratory difficulty. In both groups roentgenograms of the chest were made in four positions: posteroanterior and lateral, on full expiration and on full inspiration. These were numbered at random and submitted to a physician and three radiologists. Of the 20 patients with emphysema, all four observers made a correct diagnosis in 14 cases, three observers being in agreement on another 4. In 2 cases three observers were of the opinion that emphysema was not present. Of the control group, 4 were diagnosed as having emphysema, in each case by only one of the observers. Hence, 70 per cent of the emphysema group and 80 per cent of the control group were correctly diagnosed by all observers.

Both groups were assessed again on a posteroanterior film on full inspiration. The four observers agreed on the diagnosis of emphysema in 15 cases, three agreed on a further case and one diagnosed emphysema in another 3 cases. All were in agreement on the absence of emphysema in 1 case. There was considerable disagreement on the normal group, no less than 12 of the controls being diagnosed as having emphysema. With a single posteroanterior film, 75 per cent of the emphysema group were diagnosed correctly while only 40 per cent of the controls were passed as normal.

In summary, the authors conclude that a roentgenological diagnosis of emphysema based on a single posteroanterior film on full inspiration is of doubtful significance. A more reliable assessment may be made from films taken in the posteroanterior and lateral positions, in both inspiration and expiration, but even on this evidence about 10 per cent of cases will be missed and a few normal persons wrongly diagnosed as having emphysema.—*W. C. MacCarty, Jr., M.D.*

Gloyne, S. Roodhouse. Pneumoconiosis; a histological survey of necropsy material in 1205 cases. *Lancet*, April 14, 1951, *1*, 810–814.

This article summarizes the findings in a consecutive series of 1,247 lungs or portions thereof, examined microscopically for the presence of pneumoconiosis.

Of these, 42 were deleted because of inadequate data. Of the remainder, pneumoconiosis was not found in 169 but was present in 1,036 (silicosis 796, other forms of pneumoconiosis 240). Of the positives, 43 per cent had tuberculosis also, and 7.7 per cent had primary cancer of the lung.—*J. J. McCort, M.D.*

Stewart, Alice, and Hughes, J. P. W. Mass radiography findings in the Northamptonshire boot and shoe industry, 1945–6. *Brit. M. J.*, April 28, 1951, *1*, 899–906.

In the boot and shoe industry, 18,660 workers, and 23,738 other persons (used as controls) were examined by miniature mass survey of the chest.

The active case of pulmonary tuberculosis was found as often among men as among women in the boot and shoe industry, but in other industries women were chiefly affected. It was found that the more congested factories (more workers per room and per square foot floor area) showed a higher incidence than the smaller factories. Although the industry is such that physically handicapped persons are attracted to it, the crowded conditions of employment facilitate the transmission of tuberculosis by carriers apparently due to droplet infection.

Conclusions: (a) There is higher incidence of active pulmonary tuberculosis among the boot and shoe factory workers than in the other industries of Northamptonshire. (b) There is more disease in the larger than in the smaller factories. (c) The industry tends to employ persons of poor physique. (d) There is no evidence that leather dust, in moderate concentration, produces pneumoconiosis.—*R. K. Arbuckle, M.D.*

Scamman, Clarence L. Follow-up study of lung-cancer suspects in a mass chest x-ray survey. *New England J. Med.*, April 12, 1951, *244*, 541–544.

This is a report of a recent Mass Chest X-ray Survey in the city of Boston. This survey was initiated because of the high incidence of tuberculosis in the city, but also with the additional purpose of making a special follow-up of cancer suspects and heart lesions.

In this survey, 536,012 small films were taken. Of these, 398, or 74.2 per 100,000, were finally determined on the reading of the large film to be cancer suspects. Diagnostic reports were received on 343

of these 398 cases. Of the 343 having diagnostic reports, 76 were reported to have cancer, the other 267 being finally reported as having chest conditions other than cancer or as having no disease. Of the 76 cases reported to have cancer, 43 were proved to have primary cancer of the lung (7.8 per 100,000). Three other types of malignancy were uncovered: 1 lymphoma, 1 lymphosarcoma, and 1 Hodgkin's disease. Fifteen cases had metastatic lesions in the lung, and in 15 others the presumptive evidence indicated cancer. Of this latter group of presumptive cases, 7 refused further study; no further investigation was advised on 6; 1 is still under observation; and 1 died before diagnosis could be proved.

There were 55 patients of the 398 cancer suspects, on whom no diagnostic reports were received. Of these, 12 carried out the recommendations that they have further medical study. However, there is no final report on these, either because the diagnosis had not been finally determined or because the doctor failed to report his findings. In the remaining 43 cases, 18 patients failed to consult a doctor or clinic at all, and 25 made an initial visit to a doctor or clinic but refused to carry out additional study as advised.

Of the 267 diagnoses of chest conditions other than cancer, the majority fell into the following categories: tuberculosis—active, inactive and healed—benign tumor, tuberculoma, substernal goiter, cyst and bronchiectasis.

In addition to the 398 cancer suspects discussed in detail, 9 additional cases of cancer were discovered in the final analysis of survey films. These films were originally interpreted as tuberculous or nontuberculous lesion.

The cost of follow-up of cancer suspects is discussed.—*D. S. Kellogg, M.D.*

Brimblecome, F. S. W., Crome, L. M. C., and Tizard, J. P. M. Oil aspiration pneumonia in infancy. *Arch. Dis. Childhood*, April, 1951, *26*, 141–148.

A case history is presented of a boy of eight and one-half months who died with a lipoid pneumonia. He had been given a daily dose of three teaspoonfuls of medicinal paraffin for nearly two and one-half months. A roentgenogram shortly before death showed pneumonia in the right upper and right lower lobes. At autopsy a chemical extraction and analysis of the suspected lung was done yielding a quantity of liquid paraffin from which it was estimated that the lungs contained 13.8 grams or 16 ml. of medicinal paraffin, or slightly over one day's dose.

An oil aspiration pneumonia occurs usually in infants, but may occur in adults, mostly in individuals who have been suffering from chronic immobilizing disease or who have had local or neurogenic diseases which have resulted in dysphagia. Diagnosis may be suspected from the history but proof is difficult antemortem. Treatment is, of course, principally prophylactic. Once the condition is established, the only thing to do is to stop the administration of the suspected oil and to guard against and treat secondary infections.

The pathology is well described and other etiological agents mentioned.—*P. R. Dirkse, M.D.*

Rosendal, Thomas. Pulmonary changes in fibrosis of the pancreas. *Acta radiol.*, April, 1951, *35*, 233–245.

"During the past 10 to 15 years the pediatric literature, partly in Switzerland but especially in America, has contained an increasing number of communications about an entity which begins in infancy and is known as fibrosis of the pancreas."

The histopathological changes in the pancreas consist of blocking of the small excretory ducts and acini with a thick, often stratified secretion. The ducts and acini are dilated, the glandular cells are atrophic and there is a diffuse formation of connective tissue in the gland. There are, however, no actual inflammatory changes. The islands of Langerhans are unaffected.

The connection between meconium ileus and cystic fibrous changes were described by Landsteiner as early as 1905 but only in recent years has this association become well known.

In the lungs, too, there is a change in the mechanism of secretion with plugging of the lesser bronchi and broncioles with a viscous thick secretion. By a valve action an emphysema will develop peripherally to the plugging and atelectatic areas will also develop. Secondary infection will give rise to purulent bronchitis, peribronchial infiltration, development of small abscesses and bronchopneumonia. Interstitial fibrosis may cause further increase in the occlusion of the bronchioles so that bronchiectases may develop. The same changes may develop in the bile ducts, in the glands of the intestinal canal and in the salivary glands.

In most of the literature there is a tendency to classify the clinical picture of fibrosis of the pancreas into three types according to the time when the disease first became apparent. Soon after birth it is characterized by meconium ileus, during the first few weeks of life by respiratory infections, and after the sixth month of life the disease appears in the guise of celiac disease complicated with chronic bronchitis.

Two cases are reported. The first case was followed until death at seven months of age. The second child is still alive at three years of age. In both cases the clinical picture was dominated by respiratory symptoms. The roentgenograms of the lungs in the early stages were characterized by the presence of a localized, unilateral emphysema. Later, a diffuse increase of the lung markings and enlargement of hilar shadows appeared. The findings were those of a

bronchitis and peribronchitis as well as bronchial plugging with bronchiectasis and marked emphysema.—*Mary Frances Vastine, M.D.*

Nordenström, Björn E. W., and Norlin, Uno A. T. Bronchography with Métras' catheters. *Acta radiol.*, April, 1951, *35*, 246–249.

The use of bronchography has been increasingly indicated since the introduction of water-soluble contrast compounds. With these compounds it is desirable to have as complete anesthesia as possible so that free manipulation of the catheters in situ can be done. This is of special value in selective bronchography.

The catheters designed by Henri Métras are made of rubber and are bent so that they are suitable for the various parts of the bronchial tree. Five catheters are used, two for the upper lobes, one for the middle lobe and the apical branch of the left lower lobe and one for the lingula bronchus and the apical branch of the right lower lobe bronchus. The fifth catheter is for the straight bronchi in the lower lobes. The catheters have opaque tips. They are passed into the trachea threaded on a metal mandrin. When the catheter has passed the vocal cords the mandrin is drawn back.

The catheter is introduced into the desired bronchus under fluoroscopy. Its introduction is not difficult. The tip is moved up and down and at the same time rotated in the region of the bronchial opening whereupon it usually slips into the bronchus. The water-soluble contrast media are resorbed comparatively rapidly and one must work rather quickly.—*Mary Frances Vastine, M.D.*

Stuhl, L., Hatt, P. Y., and Sébillotte, J. La circulation artérielle pulmonaire dans les troubles segmentaires de la ventilation; exploration angiographique. (The pulmonary arterial circulation in segmental disturbances of aeration; angiographic examination.) *Presse méd.*, March 28, 1951, *59*, 393–395.

Serial angiocardiography permits visualization of the arteriovenous circulation of the lungs. Absence of circulation at the site of tuberculous cavities, diminution of pulmonary circulation in case of pneumothorax, pulmonary emboli, pulmonary vasoconstrictions, silicosis, bronchiectasis and tumors of the lungs have already been observed by angiocardiographic studies.

The authors present 7 cases of bronchial stenosis (5 bronchial carcinomas, 1 stenosis due to tuberculosis and another due to nonspecific inflammation) where there was definite circulatory deficit corresponding to the degree of disturbance of aeration. In 8 chronic pulmonary tuberculosis patients, where bronchoscopy did not reveal any bronchial stenosis, angiocardiopneumography demonstrated total circulatory exclusion in the atelectatic segments. In 5 cases of pneumothorax (therapeutic) definite reduction of arterial circulation, proportional to the contraction of the lung, was noted. A compensatory dilatation of arteries in the healthy segments of lung was observed and interpreted as a vicarious circulation. Several excellent angiocardiopneumograms accompanying the article add emphasis to the value of such studies.—*J. N. Sarian, M.D.*

Aguirre Medrano, Fidel, and Aguirre Medrano, Olga. La tomografia en el diagnostico de los tumores mediastinales. (Tomography in the diagnosis of mediastinal tumors.) *Bol. Col. Med. Habana*, April, 1951, *2*, 124–132.

Examination of the numerous structures of the mediastinum is greatly facilitated by tomograms. However, in order to interpret tomograms correctly, it is essential to have an intimate and detailed knowledge of the anatomical topography of the mediastinum.

Tomograms perform three important functions: (1) localize the disease; (2) outline the configuration and margins of the lesion; (3) demonstrate the relation and involvement of adjacent tissues. For satisfactory visualization, tomograms should be made at 1 cm. levels and extending below the level of the disease.

Tomography offers an especially effective method of studying the anterior mediastinal space, which is often involved by lymphomas. In Hodgkin's disease where infiltration of the manubrium is frequently encountered, sections through this bone may demonstrate this. In the presence of pleurisies and hydrothorax, mediastinal tumors may be very difficult to visualize by ordinary roentgen methods but can be demonstrated satisfactorily with tomograms. Tomograms are also very useful in demonstrating the presence of intrathoracic thyroid and its relation to the superior mediastinum. Metastasis to the mediastinum from a carcinoma of the lung can also be shown by this method.—*M. M. Friedman, M.D.*

Garlick, William L., and Stegmaier, James G. Benign tumors of the esophagus; report of a case of leiomyoma. *Surgery*, Jan., 1951, *29*, 109–116.

The authors present a brief summary of the pertinent literature on this subject and add 1 case of their own. Benign tumors of the esophagus are divided into 3 classes according to the relation of the origin of the tumors to the structures of the wall of the esophagus and their histopathologic characteristics.

The first class includes tumors arising from the mucosal and submucosal elements and projecting into the lumen. These are: polypi and papillomas, adenomas, epithelial cysts, fibromas, hemangiomas and lipomas. They usually hang freely in the esophageal lumen and may produce dilatation of the

esophagus, regurgitation of food, bleeding and epigastric, substernal, subscapular or supraclavicular pain. They may be associated with no symptoms. Frequently they occur in the lower third of the esophagus. There is usually a long pedicle, occasionally allowing the tumor to be regurgitated into the mouth.

The second class includes intramural and extramucosal tumors such as fibromas, lipomas, lipomyomas and leiomyomas. These are usually asymptomatic until the mucosa over them becomes ulcerated, after which there may be burning pain, nausea, regurgitation of food and fluid and bleeding. They also may cause pressure on adjacent organs.

The third class comprises tumors arising from structures outside of the esophagus. These may be dermoid cysts, aberrant thyroid tissue, and so forth. Foreign bodies may form encysted tumors in the esophageal wall.

Somewhat less than 200 of these tumors have been reported thus far and all but approximately 24 were discovered at necropsy. The symptoms produced are usually the same as those associated with carcinoma of the esophagus and should be differentiated from the latter by the history, esophagoscopy, biopsy and roentgen examination.

The authors present a short discussion of the various types of treatment that have been reported. Removal of these tumors has been by (a) snare and cautery, (b) cervical and transpleural esophagotomy and (c) resection of the tumor, with or without resection and anastomosis of part of the esophagus.

The case of a man forty-eight years of age who for seven years had episodes of regurgitating solid food and of substernal pain is presented. Roentgenographic examination demonstrated an obstruction in the middle third of the esophagus. Esophagoscopy was done and an ulcerated lesion several centimeters in length was demonstrated. Exploratory thoracotomy was undertaken and a myoma, pearly white in color and irregular in outline, was removed. It showed some areas of degeneration.

The authors indicate that a majority of these tumors should be removed by operation to prevent dilatation of the esophagus, pressure on adjacent structures and malignant degeneration.—*C. B. Holman, M.D.*

Gross, Robert E., and Neuhauser, Edward B. D. Compression of the trachea or esophagus by vascular anomalies; surgical therapy in 40 cases. *Pediatrics*, Jan., 1951, *7*, 69–88.

Vascular malformations in the superior mediastinum may partially obstruct the trachea or esophagus. Since surgical correction of these malformations is now possible their early recognition is important. The authors have summarized 40 such cases which have been studied and operated upon at the Children's Hospital in Boston. They divide the cases into five main categories. These five categories are: (1) double aortic arch; (2) right aortic arch with left ligamentum arteriosum; (3) anomalous innominate artery; (4) anomalous left common carotid artery; and (5) aberrant subclavian artery.

Each of these is described in detail, including the symptoms, signs, roentgenographic findings, and means of operative correction. Illustrative films are shown. A complete roentgenographic examination includes fluoroscopy and films with contrast media in both trachea and esophagus.

The relief obtained in these cases by proper surgery is prompt and usually complete.—*R. M. Harvey, M.D.*

Gibbon, John H., Jr., Allbritten, Frank F., and Templeton, John Y., III. Carcinoma of esophagus and gastric cardia. *J.A.M.A.*, April 7, 1951, *145*, 1035–1040.

The authors report on a series of 89 cases of cancer of the esophagus or gastric cardia seen on the surgical services of the Jefferson and Pennsylvania Hospitals between April 1, 1946, and June 1, 1950. Sixty-seven were primary esophageal lesions and 22 primary gastric lesions. Ninety-four per cent of the patients were males. In over two-thirds of the patients, the first symptom was difficulty in swallowing but it is important to note that this symptom was disregarded by either the patient or the physician for an average period of six months. With one exception the diagnosis was established by the initial roentgenologic examination.

Seventy-three patients were explored. Twenty-one were inoperable, the commonest causes being invasion of the wall of the aorta or metastasis to the lymph nodes about the celiac axis. Esophagectomy was performed in the remaining 52 patients (58 per cent of the entire series). In the 52 cases the operative mortality was 33 per cent. There was a striking variation in mortality in relation to the site of anastomosis, the figure being 50 per cent in the cervical region, 71 per cent when the anastomosis was intrathoracic but above the aortic arch, 19 per cent in anastomosis below the aortic arch, and zero for lesions of the cardia requiring total gastrectomy and partial esophagectomy.—*L. K. Sycamore, M.D.*

Salvesen, H. A., and Marstrander, F. Arterio-venous fistula of the lung. *Acta med. Scandinav.*, 1951, *139*, 167–175.

In patients with cyanosis of long standing, shortness of breath, dizziness, and sometimes syncope, in the history, and polycythemia, clubbed fingers, normal spleen and heart, and thrills and murmurs over a localized part of the lungs in the physical examination, arteriovenous fistula of the lung is suspected. Roentgenography and laminagraphy aid in confirming the diagnosis, vascular shadows being seen to connect a density in one or more lung fields with the hilar area.

Four cases are presented. Three revealed the characteristic clinical picture, but the fourth patient

lacked cyanosis, polycythemia and clubbing, and had an enlarged heart. Also, there was 96 per cent oxygenation of the arterial blood which indicates that the amount of blood passing through the fistula could not be very large.

According to the authors, in arteriovenous fistula of the peripheral circulation the right side of the heart is placed under strain, presumably because of increased venous return. In pulmonary fistulas the strain is on the stronger left ventricle, so that cardiac enlargement does not occur.

The importance of diagnosis is stressed, since this is a condition readily cured by surgery.—*Charles Nice, M.D.*

Dack, Simon, Paley, David H., and Brahms, Sigmund S. The electrokymogram in Wolff-Parkinson-White syndrome; a study of left and right ventricular ejection. *Am. Heart J.*, March, 1951, *41*, 437–447.

In the Wolff-Parkinson-White syndrome (short P-R interval combined with a lengthened QRS complex), electrocardiograms universally demonstrate premature electrical activation of the ventricles, usually of the right ventricle, but occasionally of the left ventricle. There is disagreement, however, concerning mechanical behavior of the ventricles, *i.e.*, whether asynchronism in ventricular contraction results from the ventricular pre-excitation. Auscultatory and intracardiac catheterization studies have been inconclusive on this point; the electrokymogram is the newest technique for study of the problem.

Electrokymograms of the aorta and pulmonary artery produce curves which represent left and right ventricular ejection respectively. Curves taken directly from the ventricles themselves are not as satisfactory. In normal subjects a slight asynchronism of ventricular contraction up to 0.03 sec. is frequently present.

Electrokymography has clearly demonstrated ventricular asynchronism in bundle branch block: left bundle branch block associated with delay in onset of the ejection phase in the aortic kymogram and right bundle branch block with delay in the ejection phase of the pulmonary artery kymogram. It would be expected that if ventricular asynchronism were present in the Wolff-Parkinson-White syndrome a similar lag between aortic and pulmonary artery ejection would be observed in the electrokymogram. However, detailed studies of 4 patients with this syndrome by electrokymography combined with electrocardiography, carotid pulse wave tracing, and phonocardiography were made, and showed no significant asynchronism in right and left ventricular contraction. Possible anatomical and physiological reasons for the lack of asynchronism are discussed.—*Harold Fulton, M.D.*

Moyer, John B., and Hiller, Glenn I. Cardiac aneurysm: clinical and electrocardiographic analysis. *Am. Heart J.*, March, 1951, *41*, 340–358.

This article is a review of the clinical, roentgenologic, and electrocardiographic manifestations of cardiac aneurysm. The authors' experience is based on 20 cases, 12 of which were substantiated by necropsy.

At least 85 per cent of all ventricular aneurysms follow myocardial infarction, particularly after large transmural infarcts with extensive destruction and fibrous replacement of the ventricullar wall. High intracardiac pressure during ventricular systole causes bulging of the weakened wall. At this stage, the patient may succumb to congestive failure, arrhythmia, embolism, or rupture of the aneurysm. Healing of the infarct with permanent aneurysm formation, with or without calcification of the wall, is not too uncommon, however, since the clinical incidence of cardiac aneurysm following myocardial infarction is estimated at 8–10 per cent of all cases. The factor of inadequate rest is a definite one, and only 3 of the authors' 20 cases are known to have had an adequate period of bed rest following their initial infarction.

Pathologically, most cardiac aneurysms are at the apex of the heart, usually on the anterior or anterolateral aspect of the left ventricle. Despite the frequency of posterior myocardial infarction, aneurysm in this portion of the ventricular wall is much less common.

There are no typical symptoms of ventricular aneurysm. The only important physical sign is pulsation separate from that of the apex; this finding is neither constant nor pathognomonic. There is no characteristic electrocardiographic pattern.

The roentgenologic criteria have been enumerated by Schwedel. These are:

(1) Localized bulge.

(2) Pericardial adhesions giving systolic traction on adjacent lung or diaphragmatic pleura, although all such adhesions are not due to ventricular aneurysm.

(3) Increased density due to mural thrombus which may occasionally contain calcium deposits.

(4) Ventricular incisura or angulation between the site of the bulge and uninvolved portions of the ventricle.

(5) Abnormal pulsations, either asynchronous or contrapulsile. However, and especially in the presence of a mural thrombus, pulsation may also be synchronous and systolic as well as strong or weak. When the left ventricle is enlarged, a segment which shows diminished amplitude of pulsation is not a sufficient finding for the diagnosis; combined with some of the other criteria it enhances the diagnosis.

Roentgen kymography and angiocardiography are mentioned as adjunctive diagnostic methods.—*Harold Fulton, M.D.*

Gøtzsche, H., Eskildsen, P., and Hansen, A. T. Isolated pulmonary stenosis. *Acta med. Scandinav.*, 1951, *139*, 431–444.

Among 250 patients above two to three years of age undergoing cardiac catheterization, there were 21 cases of isolated pulmonary stenosis. The diagnosis of pulmonary stenosis is tenable if, at cardiac catheterization, the pressure in the right ventricle is elevated and there is a definite decrease in pressure as the catheter enters the pulmonary artery. If the ventricular pressure is normal, the decrease in the pulmonary artery may be due to dilatation of the pulmonary artery. Other associated anomalies are ruled out during the catheterization by determining oxygen saturation at various points. Arterial oxygen saturation during work was determined by Millikan's oxymeter. In isolated pulmonary stenosis, the arterial saturation remains unchanged during work; in pulmonary stenosis accompanied by interatrial septal defect, the oxygen saturation is normal at rest but decreases during work. In Steno-Fallot's tetralogy the oxygen saturation is low at rest and decreases during work.

Clinical Picture: In this series there were 12 males and 9 females, of age range four to 38 years. Complaints were usually slight, consisting at times of dyspnea, palpitations and precordial pain on severe or moderate exertion. Three of the adult patients on exertion experienced cerebral discomfort in the form of giddiness and absent-mindedness, sometimes followed by fainting. Six patients were symptomless, including 2 with the most severe stenosis.

Clinical Examination: All were in good general condition. One twelve year old girl had slight cyanosis of the knees and shins, probably due to slow peripheral blood circulation. Bulging of the precordium occurred in 5 patients. A constant finding was a harsh systolic murmur, loud in 14, moderate in 6, and faint in 1 patient, heard best at the first left intercostal space in 1, second in 14, between second and third in 5, and in the third interspace in 1 patient. A palpable thrill was present in 15 patients. A diastolic murmur was never heard. The second pulmonic sound was greater than the second aortic sound in 9, equal in 6, and less in 6. Thus, in less than one-third the second pulmonic sound was faint or inaudible.

Electrocardiography disclosed right axis deviation in 11 of the 21 patients. In 5 of the patients the T_3 was inverted or diphasic. Slight splitting of the QRS complex was found in the second limb lead in 2 patients and in the third lead in 8 patients. One patient presented more pronounced changes in the form of large pointed P waves, and inverted T in leads II and III. Otherwise the electrocardiograms were normal.

Anatomical Picture: Peacock, in 1866, knew all three forms of stenosis of the outflow tract of the right ventricle. In *valvular stenosis* the pulmonary valves coalesce and form a diaphragm with a small central hole. This form is assumed to have arisen in late fetal life, probably resulting from a fetal endocarditis. In *fundibular stenosis* there is a constriction of the outflow tract of the right ventricle, the infundibulum or conus. The stenosis may be rather long, the conus being transformed into a narrow tube often combined with a hypoplastic pulmonary artery. In *subinfundibular stenosis* the localized stenosis is placed at the transition between the ventricle proper and the infundibulum, the ventricle thus being divided into two cavities. The right ventricle is enlarged in all three types and frequently there is post-stenotic dilatation of the pulmonary artery.

If the tip of the catheter is observed carefully during fluoroscopy the pressure tracings may indicate the anatomical type of stenosis. In valvular stenosis there is a sudden change in the pressure tracing from the pulmonary shape to the ventricular, when the tip of the catheter is withdrawn through the pulmonary ostium. The long infundibular stenosis shows a gradual transition. In subinfundibular stenosis there is a normal transition from the pulmonary curve to the ventricular curve corresponding to the passage of the catheter tip through a normal pulmonary ostium, but further down in the ventricle the pressure rises suddenly.

Roentgenologic Picture: Heart size was usually normal in this series. In 10 patients a slight bulbing of the anterior contour was noted in the left anterior oblique projection. The enlargement is better displayed in the right anterior oblique projection. In 14 patients the second arch on the left cardiac border was prominent in the posteroanterior projection. The pulsation was prominent in some, weak in others. None had increased vascular markings of the hila or lungs. However, none showed the delicate vascular markings often seen in Steno-Fallot's tetralogy. In 7 patients the roentgenographic picture was not at all typical. In 2 patients the shape of the heart was normal and in 4 patients the conus region on the left cardiac contour was aplasic, thus resembling Steno-Fallot's tetralogy. One patient had a distinct enlargement of the right atrium.—*Charles Nice, M.D.*

Bustamante Marcayda, Rodrigo; Estrada, Rafael; and Fuste, Frederico. Topografía radiológica de las arterias coronarias. (Roentgenologic topography of the coronary arteries.) *Arch. Hosp. Universitario*, Habana, Nov.–Dec., 1950, *2*, 709–722.

The coronary arteries in man have occasionally been seen in the course of an angiocardiographic examination, and more frequently in techniques for visualizing the thoracic aorta. Calcification of the coronary vessels has also helped in rendering them visible roentgenographically. Postmortem injections

of the coronary arteries have been done by others.

In this work stillborn fetuses at term were used. A sound was introduced into the ascending aorta and a gelatin preparation of barium sulfate was injected. Metallic markers were employed to indicate the position of the right anterior coronary artery for reference. When the opaque substance ran into the left heart, the coronary arteries were obscured and the preparation was useless. Ten technically satisfactory injections were made and the results are reported. Roentgenograms and diagrams in the paper indicate positions of vessels in various projections of the heart.

The right coronary artery is best seen in the posteroanterior projection where it normally describes a curve along the right border of the heart. For the anterior descending coronary artery the right anterior oblique projection is probably ideal, because the vessel forms the anterior border of the cardiac silhouette down to the apex of the heart. In the left anterior oblique projection the left circumflex coronary artery occupies the posterior border of the cardiac silhouette.

These observations may be useful if coronary arteriography becomes of clinical importance.—*Norman Simon, M.D.*

Vieten, Heinz. Erfahrungen bei der Bronchographie mit wasserlöslichen Kontrastmitteln. (Experiences with bronchography using water-soluble contrast media.) *Röntgen-Blätter*, March, 1951, *4*, 80–109.

The author has performed 1,000 bronchographies using perabrodil M (60 per cent), made more viscous by the addition of an acetylated cellulose. This water-soluble contrast material is many times more viscous than lipiodol, yet has a lower surface tension so that drop formation is avoided and smooth coverage of the mucous membrane lining of the bronchial tree results. It contains only 25 per cent iodine in an organically combined form, yet produces on films a shadow of high intensity. The contrast substance is rapidly eliminated from the body through the kidneys and completely disappears from the lungs in a period of three hours or sooner. The cellulose component cannot pass the kidney filter and is phagocytosed; the reported resultant granuloma formation and its possible harmful effects are being investigated.

Perabrodil M causes marked irritation of the bronchial mucosa and may lead to uncontrollable cough which will prevent completion of the bronchographic examination. The proper premedication and anesthetization of the patient should therefore be stressed. Vieten states that the patient should be fasted and given 0.1 gm. luminal by mouth the evening before the examination. About two hours before the bronchography an injection of 0.1 gm. luminal and 0.25 to 0.5 mg. atropine is given. For local anesthesia, a maximum of 5 cc. of 2 per cent pantocaine is used. Anesthetization of the throat, pharynx, trachea, and bronchial tree are carried out by the supraglottic route.

Bronchography performed by the "unaimed" method whereby the contrast fluid is introduced into the trachea and the patient positioned to fill all of the segments of the bronchial tree is not of too great value when the water-soluble material is used. By "aimed" bronchography using a catheter or sound (Vieten prefers the Métras type), each lobe bronchus and each segmental bronchus can be individually sounded under fluoroscopy and the contrast material instilled. After the suspected segments are demonstrated, the sound can be withdrawn to the level of the tracheal bifurcation and a simultaneous demonstration of all segments performed. The "aimed" method using the water-soluble contrast material has the advantage that a suspicious segment can be refilled again in a short time, due to the rapid absorption of the contrast material, without the addition of confusing shadows.

Perabrodil M has proved to be of advantage in: (1) Bronchiectasis; the water-soluble material mixes easily with the thick bronchial secretions; there is no drop formation as often occurs with oily contrast media. (2) Lung abscess; the water-miscible substances will pass through small fistulae which will not admit the usual contrast fluids. (3) Tuberculosis; perabrodil M was used by the author for control study of tuberculous bronchiectasis, bronchial stenosis due to tuberculous granulation, and for demonstration of residual cavities following collapse therapy. Vieten mixes streptomycin and penicillin (no units mentioned) with the contrast material and believes that this reduces the hazard of its use in tuberculosis cases.—*Harold Fulton, M.D.*

Keeffe, Eugene J., and Jones, Clifford F. Pneumomediastinum in the newborn; report of a case. *Radiology*, April, 1951, *56*, 567–570.

Pneumomediastinum in the newborn, occurring without pneumothorax, is a rare condition. It is significant that in all the cases of pneumomediastinum previously reported some form of artificial respiration had been administered. Mediastinal emphysema is usually manifested by respiratory and circulatory distress with a rapid and shallow respiration.

It is important to obtain roentgenograms in the anteroposterior and lateral projections. In the lateral view, marked bulging of the precordium with a large area of encapsulated air immediately posterior to the sternum is characteristic of pneumomediastinum. The course is usually uneventful and the treatment consists of the use of oxygen and stimulants. In some cases it may be necessary to aspirate the air from the mediastinum.

The authors present one case report.—*E. M. Cooper, M.D.*

Soto, José A. El neumo-mediastino artificial en la exploración del timo. (Artificial pneumomediastinum in the exploration of the thymus.) *Curso de Perfeccionamiento*, 1949, *20*, 399–415.

Mediastinal pneumography is not a new method of examination. The author is convinced that it is necessary because thymic shadows are more frequent than is generally thought. Our Cuban colleagues, Pereiras and Castellanos (1938) were the first to apply artificial pneumomediastinum.

The author concludes that roentgenologic visualization of the thymus does not always indicate its enlargement. The normal thymus is very often visible roentgenologically by ordinary study, but it is always visible by pneumomediastinum. The procedure should not be employed blindly; it has its precise indications. When the thymus is clearly visible by ordinary study, pneumomediastinum is not employed. Its principal indication is in cases of atypical mediastinal shadows frequently observed in lactating children who have been suspected of having enlarged hearts. Another indication is the straightness and double contour of the left cardiovascular shadow, also pseudoarcuate mediastinal shadows.

The author has had no complications in 30 personal cases done on children forty-eight days to three years of age.—*J. T. Case, M.D.*

Bernstein, Arthur, Klosk, Emanuel, Simon, Franklin, and Brodkin, Henry A. Large thymic tumor simulating pericardial effusion. *Circulation*, April, 1951, *3*, 508–513.

The authors report an interesting case of an asymptomatic thymoma which enveloped the pericardium in a twenty year old male. It was discovered on a routine chest roentgenogram. Because of its "fluidity" it simulated pericardial effusion, and adjusted itself to the shape of the surrounding structures. In spite of its appearance, the clinical findings were against pericardial effusion. The heart was proved to be of normal size by tomography and angiocardiography. However, only at surgery was the true nature of the tumor discovered. Gynecomastia was present and its relationship to mediastinal tumor is discussed. The value of streptokinase in liquefying postoperative clots is noted. Recovery was complete.—*Norman Heilbrun, M.D.*

Palazzo, William L., and Garrett, Thomas A. Cervical hernia of the lung. *Radiology*, April, 1951, *56*, 575–576.

Cervical hernia of the lung occurs through the superior aperture of the thorax in the space between the sternocleidomastoid muscle and the scalenus anticus muscle, either as a tear or as a deficiency in Sibson's fascia.

The authors add one case of cervical hernia of the lung to the literature. This case is of interest because it is the second bilateral hernia to be recorded, and because it was discovered on the forty-eighth day of life. The patient also had cleft lip and palate, and it is suggested that the herniated lung may be the result of a congenital defect.—*E. M. Cooper, M.D.*

Leininger, C. R., Gibson, Stanley, and Potts, Willis J. Congenital pulmonary stenosis, postoperative observations on two hundred and fourteen children. *Am. J. Dis. Child.*, April, 1951, *81*, 465–470.

This paper is a review of the first 214 cases in which a Blalock or Potts-Smith procedure was attempted at the Children's Memorial Hospital, Chicago. An anastomosis was possible in 190 patients. Eighteen children (9 per cent) died in the immediate postoperative period; 1 child died in an automobile accident three months after operation, and 35 children were not seen following operation.

The remaining 145 children were observed for postoperative periods ranging from six to twelve months. Eight of these children (5.5 per cent) died from various causes during the period of observation. The degree of improvement in the surviving children as shown by changes in cyanosis and exercise tolerance, as well as the degree of cardiac enlargement is described in detail in the paper. The authors believe that proper postoperative evaluation of these patients will require at least ten to fifteen more years. The procedure would seem to be justified by the immediate relief of symptoms, with a change from a life of invalidism to one of relative normalcy. —*R. S. Bromer, M.D.*

Reinhardt, K. Atélectasie pulmonaire gauche totale après bronchographie. (Total left pulmonary atelectasis following bronchography.) *J. de radiol. et d'électrol. & Arch. d'électric. méd.*, 1951, *32*, 470–473.

There is a trend in present-day medicine to accept the concept that certain forms of extensive pulmonary atelectasis occur on a neuromuscular reflex basis.

In support of this theory the author reports in detail the case of a forty-two year old man in whom bronchography led to a total atelectasis of the left lung. The examination was performed with the pupose of differentiating between tuberculous infiltrations and bronchiectasis with peribronchial infiltrations. Ten cubic centimeters of 20 per cent lipiodol was injected by means of a rubber tube into the left main bronchus following local anesthesia with 2 per cent novocaine. Immediate roentgenograms revealed a typical appearance of bronchiectasis with inflammatory changes of the peribronchial parenchyma and the presence of multiple small

abscesses. Repeated sputum examinations remained negative for tubercle bacilli.

Penicillin was administered by endotracheal instillations and by injections. Since there was no improvement, three weeks later additional roentgenograms of the chest were made. These revealed total atelectasis of the left lung. A slightly translucent semilunar zone was present in the region of the left hilus, which was interpreted as herniation of the right lung and mediastinum into the left hemithorax secondary to atelectatic retraction of the left lung. Sixteen days later, still further roentgenograms were made. These showed identical findings. To rule out the vague possibility of obstruction, the author at this time performed a second bronchographic examination by injecting 20 cc. of lipiodol into the left main bronchus. The opaque medium passed freely into the narrowed and greatly distorted left bronchial tree. The herniation of the right lung into the left hemithorax was clearly demonstrated.

In conjunction with this observation, the author reviewed the literature and found that only very few similar cases were reported. It was generally agreed that the cause of the lesion must be sought in a neuromuscular reflex mechanism the anatomic bases of which are not sufficiently established as yet. Sturm gave the following classification of this type of atelectasis:

(1) Atelectasis provoked by a central lesion (trauma, purulent leptomeningitis, poliomyelitis, etc.).

(2) Atelectasis provoked by a lesion of the cervical region (tonsillectomy, diphtheria, epistaxis, exeresis of the phrenic nerve, etc.).

(3) Atelectasis provoked by lesions of organs supplied by the splanchnic nerves (postoperative, traumatic, cholecystitis, hepatitis, parturition, cancer, etc.).

(4) Atelectasis due to irritation of the thoracic segmental innervation:

(a) cutaneopulmonary segmental reaction.

(b) intercostovertebral pulmonary segmental reaction (fracture of ribs or vertebrae, thoracic contusion, tuberculous spondylitis, etc.).

(c) Pleuropulmonary segmental reaction (pleuritis, pneumothorax, etc.).

(d) cardiopulmonary segmental reaction (atelectasis accompanying cardiopathies).

Reflex atelectases produced by injection of lipiodol have also been described by several investigators. They usually were transitory. The long duration observed in the author's case is exceptional. It is attributed to the chronic suppurative inflammation causing prolonged irritation of the pulmonary innervation.—*T. Leucutia, M.D.*

Jones, Russell S., and Alley, Frank H. The role of the bronchi in pulmonary tuberculosis; a review based on a study of 305 cases. *Am. Rev. Tuberc.*, April, 1951, *63*, 381–398.

A study of bronchial tuberculosis has been made by the authors utilizing specimens of lungs obtained at operation and postmortem examinations. This study includes microdissection of the lung tissue after fixation. The form, incidence, and pathogenesis of bronchial tuberculosis are discussed. Tuberculosis of the large bronchi was seen most frequently in association with cavitation and sputum bearing tubercle bacilli. The bronchi frequently are avenues of spread for the tubercle bacillus to other portions of the lung than that primarily involved.—*W. A. Klauber, Jr., M.D.*

Donaldson, S. W., Tompsett, A. C., Grekin, R. H., and Curtis, A. C. Sarcoidosis. V. The effects of pregnancy on the course of the disease. *Ann. Int. Med.*, May, 1951, *34*, 1213–1218.

Since many workers think that sarcoidosis is a noncaseative form of tuberculosis and, since it is an established fact that active tuberculosis is a contraindication to pregnancy, 3 patients with active sarcoidosis followed during and after their pregnancies are reported.

Case 1 revealed an increase in lung findings three months after her first pregnancy. These showed a marked improvement in nine months. Following a second normal pregnancy no change was noted on roentgenological examination and the patient remained in good health.

Cases II and III revealed no change in the clinical course of the disease during or after pregnancy.

The authors believe that sarcoidosis is not a contraindication to pregnancy.—*F. H. Squire, M.D.*

Johnson, C. Clifford, Hanson, Norbert O., and Good, C. Allen. Erythema nodosum; the possible significance of associated pulmonary hilar adenopathy. *Ann. Int. Med.*, April, 1951, *34*, 983–997.

Erythema nodosum has been considered to be associated with several diseases including tuberculosis, sarcoidosis, coccidiosis, and rheumatic fever by different investigators. In some of these diseases hilar adenopathy is commonly found.

The present article includes a study of 100 consecutive proved cases of erythema nodosum which were seen at Mayo Clinic up to April, 1948. All of the cases had roentgenograms of the chest at the time the skin lesions were present. Nine of these cases revealed hilar adenopathy, eight showing bilateral involvement. In 5 of the cases follow-up films of the chest were made and in 4 of these the adenopathy cleared within seven months. The 1 case in which the adenopathy persisted also showed persistent cutaneous lesions of erythema nodosum. In all of the cases, no other cause for the adenopathy could be found. In the 4 cases in which the adenop-

athy disappeared the regression occurred following the recession of the erythema nodosum.

The authors believe that if hilar adenopathy is found in conjunction with erythema nodosum the possibility of its being the result of this disease alone should be considered along with the other usual possibilities. If other causes cannot be demonstrated, disappearance of the enlarged lymph nodes can be anticipated as the erythema nodosum subsides.—*F. M. Windrow, M.D.*

Winn, William A. Pulmonary mycoses—coccidioidomycosis and pulmonary cavitation; a study of ninety-two cases. *Arch. Int. Med.*, April, 1951, *87*, 541–550.

The residua of pulmonary coccidioidal disease may be listed as single or multiple solid foci, coccidioma, persistent hilar adenopathy, cavitation, calcification and, less often, localized bronchiectasis and fibrosis. Of these lesions, the residual cavity has been most intriguing; it may vary in size from 1 to 14 cm. and hemoptysis is present in 65 per cent.

Analysis of a series of 92 patients with residual cavities showed that in one-fourth the cavity closed spontaneously and in 10 per cent it persisted for a "number of years" without harm. The cavity filled and formed a solid nodule in 6 per cent of the patients. Pneumothorax resulted in 2 per cent.

Excessive bleeding and progressively increasing size necessitated collapse measures such as pneumoperitoneum or pneumothorax in one-third of the series. These measures were successful in 18 cases; unsuccessful in 10. Surgical measures, varying in extent from simple excision to pneumonectomy, were used successfully in 14 patients.

In conclusion, the author indicates that it is not necessary to isolate these patients and that the normal home life may be maintained.—*I. R. Berger, M.D.*

Peabody, Homer D., Jr., Moersch, Herman J., and Edwards, Jesse E. Clinically indeterminate pulmonary fibrosis; a pathologic study. *J. Thoracic Surg.*, May, 1951, *21*, 519–531.

Physicians are often confronted with the problem of diagnosis and treatment of a patient who has shortness of breath, cough, and at times cyanosis, either with or without positive physical signs. The roentgenogram of the chest shows bilateral parenchymal infiltration of indeterminate nature, and additional study may fail to reveal the underlying cause. The term "pulmonary fibrosis" is often used to categorize these patients.

An analysis was made of the records of 647 cases of bilateral pulmonary fibrosis encountered at the Mayo Clinic. Fifteen cases were selected for detailed study on the basis of the following criteria: (1) clinical diagnosis of bilateral pulmonary fibrosis of unknown cause, (2) adequate case history, physical examination, and laboratory study, and (3) pathologic specimens available. A brief account of the clinical picture and postmortem findings in each of these 15 cases is presented.

In the 15 cases the following pathologic conditions were observed: infectious disease, 3 times; malignant neoplastic disease, 4 times; disease of the blood, once; circulatory disturbances, twice; bonchiectasis, 4 times; and indeterminate diffuse interstitial fibrosis, once.

An adequate anatomic diagnosis may be made in the great majority of cases of clinically indeterminate bilateral pulmonary fibrosis, but a specific etiologic factor cannot always be named.—*T. C. Stansbury, Jr., M.D.*

Ehrecke, Karl-Heinz. Über die Aluminiumlunge. (Concerning the aluminum lung.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, April, 1951, *74*, 408–411.

The author reports a case of aluminum lung which is unusual since the first symptoms occurred about ten years after exposure in contrast to most other cases which are fatal within a few years after being exposed to the aluminum dust.

This patient came to observation because of increasing dyspnea and expectoration. The temperature was normal, the sedimentation rate was not increased and the sputum was negative for tubercle bacilli.

Roentgenologically there were extensive streaky and cloudy densities, particularly in the upper lung fields with displacement of the trachea to the right, extensive localized pulmonary emphysema accompanied by bronchiectatic cavities proved also on bronchograms. The paratracheal and bifurcation lymph nodes were extensively enlarged.

The author considered it as remarkable that only two years of exposure were sufficient to cause such extensive damage to the lungs.—*H. P. Mueller, M.D.*

Heiken, Charles A., and Wiese, E. Robert. Löffler's syndrome; transient pulmonary infiltration with eosinophilia. *Am. Rev. Tuberc.*, April, 1951, *63*, 480–486.

The authors describe the various clinical and roentgenographic findings in Löffler's syndrome and report 2 new cases of their own. The condition is considered to be a manifestation of an allergic response within the lung to a number of different allergins. The outstanding roentgen findings are the extensive infiltrations of the lung, which are far out of proportion to the severity of clinical symptomatology. In fact, these cases are usually discovered by accident during mass chest roentgenography or during examination not related to complaints from the patient's disease.

Due to the increase in the number of chest surveys the diagnosis may be expected to be made more frequently in the near future. The triology of absence of symptoms (or of slight symptoms), transient successive infiltrations of the lungs, and an elevated percentage of blood eosinophils should be borne in mind constantly.—*W. A. Klauber, Jr., M.D.*

Gobbel, Walter G., Jr., Gordon, Joseph, and Digman, George J. The pulmonary artery in bronchiectasis. *J. Thoracic Surg.*, April, 1951, *21*, 385–390.

The pulmonary arteries were studied by injecting them with iodized oil. Lung specimens were obtained from the operating room or the autopsy table and immediately injected under fluoroscopic observation. Roentgenograms were then made. Normal lungs and those with classical lesions of tuberculosis and bronchiectasis were studied.

A normal arterial pattern was found in the lungs with nontuberculous bronchiectasis. Following resection of the bronchiectatic portion of the lung, there is an increase in the arterial oxygen saturation. This improvement is thought to be due to the removal of the poorly ventilated but adequately circulated diseased portion of the lung which is acting as a venous-arterial shunt mechanism. Respiratory physiologic studies support this observation.

In fibrocaseous pulmonary tuberculosis, there is an irregularity of the large branches and a marked paucity of the small branches in fibrotic areas and complete absence in areas of caseation. The absence of circulation in the poorly ventilated areas is an explanation for the findings of normal arterial oxygen saturation in pulmonary tuberculosis at rest despite loss of considerable pulmonary tissue.—*T. C. Stansbury, Jr., M.D.*

Hanelin, Joseph, and Eyler, William R. Pulmonary artery thrombosis; roentgen manifestations. *Radiology*, May, 1951, *56*, 689–703.

Thrombosis in the pulmonary arterial tree, especially in the smaller vessels, is relatively infrequent; as a rule, it does not result in infraction. The roentgenographic detection of a pulmonary infarct presents a difficult problem for the roentgenologist. When infarction has occurred, one must search for evidence of thrombosis in the pulmonary arteries.

The most common etiologic factor in pulmonary arterial thrombosis is embolism from the systemic veins or from the right heart. Thrombosis may occur in situ. Clinically the initial signs and symptoms may be either insidious or of dramatic onset.

Five cases of thrombosis of the main pulmonary artieries or their major branches are discussed in detail. The following changes were found: (1) dilatation of the vessels proximal to the block, (2) enlargement and alteration in contour of the vessel at the level of the thrombus, and (3) decrease in the caliber of the vessels distal to the thrombus causing increased radiolucency in the corresponding area of lung.

In those cases of long duration in which thrombosis produces considerable obstruction, cor pulmonale and eventual right heart failure develop.—*E. M. Cooper, M.D.*

Doty, Robert D. Bronchial adenoma; nomenclature and present methods of treatment. *J. Thoracic Surg.*, April, 1951, *21*, 349–361.

There is a great deal of confusion about both the nomenclature and the treatment of bronchial adenoma. The author suggests that "adenoma" be reserved for the group as a whole, that "carcinoid adenoma" and "mixed tumor adenoma" be used exclusively in classifying them since they are adequately descriptive terms and have been previously used. The term "cylindroma" should be discarded. Both of these tumors are of low grade malignancy, and they invade the mediastinum by metastasis or direct extension. It would seem that no purpose is served in segregating them as far as definitive treatment is concerned.

The author presents 5 cases of bronchial adenoma. Three of the 5 cases could not have been treated properly by the bronchoscopic method alone. He believes that nothing less than surgical exploration can offer clear evaluation of the condition and permit definitive treatment because the bronchial adenoma extends or metastasizes peribronchially and to the mediastinum.—*T. C. Stansbury, Jr., M.D.*

Delarue, N. C. Bronchial adenoma; analysis of 26 cases. *J. Thoracic Surg.*, May, 1951, *21*, 535–542.

Recently there has been an increasing volume of literature dealing with a type of bronchial neoplasm most commonly designated as an "adenoma." There has been a sharp controversy involving both the pathologic interpretation and clinical management of these lesions.

This is a statistical analysis of 26 cases of proved bronchial adenoma presented in tabular form, outlining the symptomatology, the roentgenological, and bronchoscopic findings, and the pathologic attributes of this neoplasm. In a similar tabular form the operative results are presented with an analysis of the operative and postoperative mortality, the postoperative morbidity, and the survival rates.

A review of the pathologic findings, with reports of 3 additional cases pertinent to the discussion, suggests that this lesion begins as a benign neoplasm with a definite potentiality toward malignant degeneration that affects the course and consequently the treatment necessary. Of the 26 cases, 14 were considered benign and 12 classified as "malignant adenoma." In 2 cases there was actual lymph node involvement.

On the basis of these observations, a limited pulmonary resection or lobectomy is recommended as the treatment of choice unless the presence of mediastinal lymph nodes or involvement of a main bronchus necessitates a pneumonectomy. The high incidence of extrabronchial extension (9 cases), together with the other signs of malignant degeneration, and the instances of recurrence after apparently complete removal eliminates the bronchoscopic method of excision except in those cases where the patient cannot tolerate thoracotomy.—*T. C. Stansbury, Jr., M.D.*

Graham, Evarts Ambrose. Primary cancer of the lung with special consideration of its etiology. *Bull. New York Acad. Med.*, May, 1951, *27*, 261–276.

Bronchogenic carcinoma differs from other cancers (1) in that it has shown an enormous increase in the last thirty-five years, and (2) in that it has developed a progressively larger incidence in the male sex. It has changed its position in carcinomas of men from about the eighth to the first place during this period. Its ratio of occurrence between males and females has also changed from 4.5 to 1 to about 18 or 20 to 1 during the same time.

Prolonged excessive cigarette smoking is thought to be an important etiologic factor although not the only one, as 2 per cent of those who had bronchogenic carcinoma never smoked. In Iceland, where prior to World War II, the amount of cigarette smoking was much less than elsewhere, primary carcinoma of the lung is still rare.

The difference in incidence between men and women is attributed to the fact that women have not been smoking excessively for a long enough period of time.

The largest group of bronchogenic carcinoma comprises the squamous or epidermoid type which has shown the greatest increase. The undifferentiated types seem to be variants of the epidermoid type.

The tumors belonging to the other main group are called: bronchial adenoma, cylindroma, carcinoid, oat cell, round cell or adeno-carcinoma. The author believes they may arise from latent fetal bronchial buds. These tumors are about equally distributed between the sexes. There is no convincing evidence that cigarette smoking has any etiological influence in the production of carcinoma of this group. If a bronchogenic carcinoma occurs in a non-smoker, it most likely will be diagnosed as an adenocarcinoma or one of its variants.

Epidermoid carcinomas are believed to be most likely initiated by metaplasia of the adult bronchial epithelium due to the action of one or more carcinogenic agents such as smoking.

The recently recognized alveolar carcinoma, or multiple adenomatosis or carcinoma mucocellulare, shows great resemblance, clinically, grossly and microscopically to a disease of sheep known as "jagziekte" and is thought to be due to a virus. The lesion is briefly discussed.—*C. W. Cooley, M.D.*

McCoy, Herbert I. "Alveolar-cell" carcinoma of the lung. *Ann. Int. Med.*, April, 1951, *34*, 968–982.

These tumors are relatively rare. They are distinguished from other pulmonary neoplasms by a regular layer of nonciliated, cuboidal to low columnar cells which line the alveoli, and by the absence of primary bronchial involvement.

Two cases are presented. These were characterized by a nonproductive cough, dyspnea, weight loss and rapidly retrogressive course. A diagnosis of malignant neoplasm by examination of bronchial secretions was made by Dr. Papanicolaou but the cell type was not identified. In only 1 of the approximately 75 reported cases has the diagnosis been made antemortem and this one was made consequent to lobectomy. In 1 case which was seen by the author after this paper was submitted, Dr. Papanicolaou suggested "alveolar cell" carcinoma and it was confirmed at autopsy.

The roentgen examination usually reveals a diffuse mottling which is most dense about the hila and radiates well out into the periphery. The appearance suggests the possibilities of miliary tuberculosis, sarcoidosis, fibrosis from irritants which have been inhaled, mycotic infections, and acute fibrosis as well as alveolar cell carcinoma. The roentgen findings, even with the clinical signs and symptoms, are not sufficiently characteristic with our present knowledge to permit a conclusive diagnosis.

Alveoli, the walls of which appear unaltered, form the stroma. They are lined by a single to psuedostratified layer of nonciliated cuboidal or columnar epithelium. Papillary projections of tumor cells may protrude into the lumen. There is no invasion of the bronchial elements. The site of origin of the tumor cells is controversial and several theories as to their origin are presented.

When the roentgen findings are suggestive of alveolar cell carcinoma, cytological examinations of the sputum and bronchial washings and a needle biopsy may lead to a positive diagnosis.—*F. M. Windrow, M.D.*

Potts, W. L., and Davidson, Horace B. Bronchiogenic neoplasm masquerading as alveolar cell carcinoma; with report of a case clarified only by autopsy. *J. Thoracic Surg.*, April, 1951, *21*, 402–420.

More than 70 cases of human alveolar cell carcinoma have been reported under varying nomenclature. Many do not believe, however, that the tumor is primarily alveolar in origin and feel they have demonstrated direct communication between a responsible bronchial site and involved alveoli. Those favoring primary alveolar tumor as an actual

clinical entity point out certain characteristics which are said to clearly distinguish it from all other malignancies. These include (a) reduplication of alveolar pattern by cells whose morphology differs entirely from that of bronchiogenic carcinoma, (b) failure to identify primary neoplasm elsewhere, (c) multicentricity.

A case is reported in detail. Diagnosis of primary alveolar cell carcinoma seemed well established through histopathologic examination of bronchoscopic biopsy material, resected pulmonary tissue, and gross autopsy findings, as well as through exfoliative studies of bronchoscopic aspirations and sputum. Microscopic autopsy section study definitely disclosed a true primary bronchiogenic adenocarcinoma. Clearly identified metastases were present in the lung and other viscera and had definitely assumed that pattern described as typical of alveolar cell tumor.

Study of this case, in reference to others previously reported, would infer that several of the latter might not have represented true primary alveolar carcinomas. Some support is offered Herbut's contention that none are of the latter type, and that true bronchiogenic origin was not established simply because of disappearance under metastatic invasion. —*T. C. Stansbury, Jr., M.D.*

Stenstrom, John D. Bronchogenic carcinoma; analysis of ninety-four cases. *Canad. M. A. J.*, May, 1951, *64*, 409–413.

In this series of histopathologically verified lung cancers, the commonest site was the right main bronchus followed by the left upper and the right upper lobes. The sex distribution was 82 males and 12 females. The right lung harbored 56 per cent of the lesions. Ten patients and a history of chronic bronchitis with 1 instance of pulmonary tuberculosis.

Thoractomy was done in 23 patients of whom 14 had pneumonectomy and 2 resection of lobes. Operative mortality was attributed to anoxia, hemorrhage, air embolus and pulmonary embolus in 1 patient each with 2 instances of bronchopleural fistula. Surviving patients had been followed twenty-eight months or less.

In the discussion that follows, Harrison suggests that, when the lesion is found to be inoperable at the thoracotomy, the vagus nerve be sectioned immediately below the recurrent laryngeal nerve. This procedure seems to diminish the discomfort from the troublesome symptom of cough.

Homer advocates aspiration biopsy in selected patients. He mentiones one example of a primary nodular carcinoma in the lung, which otherwise might have been regarded as a metastatic nodule from an earlier malignant melanoma of the left hand.

Ferris feels that bronchoscopy should give the correct diagnosis in 40–50 per cent of cases; examination of the sputum and secretions in 80 per cent and that the other suspected but preoperatively indeterminate cases should be explored. Twenty per cent of the lung cancers seen by him fell in the latter category.—*J. W. Turner, M.D.*

Papanicolaou, George N., and Koprowska, Irene. Carcinoma in situ of the right lower bronchus; a case report. *Cancer*, Jan., 1951, *4*, 141–146.

This article stresses the importance of cytological methods of diagnosis in bronchogenic carcinoma. The early, preinvasive lesions can be detected by histological studies of the sputum and bronchial washings owing to the early exfoliation of cancer cells. The cytological criteria for the diagnosis of malignancy are discussed and listed.

A case is presented in which the diagnosis was established conclusively from cytological studies of the sputum and bronchial washings, while bronchography and bronchoscopy were negative. The patient died of lobar pneumonia and the tumor could not be identified grossly on the pathological specimen. Only by serial sections of the bronchi could the neoplasm be demonstrated and in no section was invasion seen. Atypical epithelium and squamous metaplasia were observed in both lungs, and whether this bears any relation to the carcinoma in situ is questionable.

In the description of the cytological changes, the similar structural alterations seen in carcinoma of the uterine cervix are of interest.—*J. W. Wilson, M.D.*

Hauser, Theodore E., and Steer, Arthur. Lymphangitic carcinomatosis of the lungs; six case reports and a review of the literature. *Ann. Int. Med.*, April, 1951, *34*, 881–898.

The common metastatic carcinoma in the lung produces one or more discrete nodules with no definite relationship to the blood vessels or lymphatics. Pulmonary symptoms do not usually appear until in the later stages of the disease.

In another form, roentgenograms of the chest show a pattern of thin, stringy lines with frequent interweaving, which branch outward from the hilus. This picture, along with the clinical findings of severe progressive dyspnea, cough with only scant mucoid sputum, chest pain, weight loss, anorexia and cyanosis is highly suggestive of lymphangitic carcinomatosis of the lung. If tuberculosis, fungus disease and occupational inhalation disease can be ruled out, a diagnosis of carcinoma should be made.

The physical signs are few and vague. Occasionally, medium or sibilant rales are heard. Cor pulmonale may occur and rarely a pleural effusion is observed.

The most frequent primary lesion is in the stomach, and the next most frequent in the lung itself. The mode of spread is probably by retrograde extension of the tumor cells along the lymphatic

channels. When this occurs, regardless of the primary site, a diffuse pulmonary fibrosis and an obliterative arteritis are always found. These usually account for the clinical findings.

The authors present 6 cases of lymphangitic pulmonary carcinomatosis, all of which conform fairly well to the above description.—*F. M. Windrow, M.D.*

COURNAND, ANDRÉ. Newer methods in the diagnosis of congenital cardiac anomalies. *Bull. New York Acad. Med.*, May, 1951, *27*, 277–294.

Cardiac catheterization and angiocardiography have added considerably to the knowledge and diagnosis of congenital cardiac and vascular anomalies. The author emphasizes that the data obtained from these methods must be carefully correlated with the clinical findings.

Cardiac catheterization is done by introducing a radiopaque catheter into the venous system. Under fluoroscopic control the catheter tip can be directed into the superior and inferior vena cava, right auricle and right ventricle, the pulmonary artery and its branches. Blood samples are taken from the above regions and analyzed. Intracardiac blood pressure is also measured. Abnormal communications between the right-sided structures and the left-sided structures, may be shown.

The complications from cardiac catheterization are: air emboli, thrombosis secondary to endocardial trauma, acute anoxia following catheterization of a markedly stenotic pulmonary valve, and arrhythmias. Arrhythmias are the most important and occur most often when the tip of the catheter is in the infundibular region of the right ventricle or is introduced into the left ventricle through a septal defect. The mortality rate of cardiac catheterization is about two-tenths of one per cent.

Angiocardiography consists of roentgen visualization of the cardiac chambers and great vessels by means of an intravenously injected radiopaque solution. It is possible to demonstrate the contour of the four cardiac chambers and the great vessels and to follow the sequence of their filling with blood containing the radiopaque solution. Thus various cardiac and vascular anomalies can be shown. The procedure is not without risk as in a group of 7,000 angiocardiographic studies, 26 deaths occurred which could be attributed to the injection of the radiopaque substance.

The author discusses the results of cardiac catheterization and angiocardiography in the (A) noncyanotic and (B) cyanotic types of congenital cardiac anomalies.

(A) The more common anomalies in the noncyanotic group are: coarctation of the aorta, patent ductus arteriosus, interventricular and interauricular septal defects, and pulmonic stenosis either isolated or associated with a septal defect through which there is no reversal of the natural direction of the shunt.

Angiocardiography is essential in coarctation of the aorta as the site of the constriction can be demonstrated. The examination usually reveals that the left ventricle is enlarged, the ascending aorta is slightly dilated, the innominate artery and the left subclavian artery are greatly dilated, there is a long narrow transverse aortic arch, the constriction site appears as a short stub extending downward and posteriorly beyond the subclavian artery, and the descending aorta is frequently dilated and overlaps the stub slightly. The opening between the two segments as a rule, is not readily demonstrated. Cardiac catheterization has no place in coarctation of the aorta.

In most cases of patent ductus arteriosus the diagnosis is obvious and cardiac catheterization and angiocardiography are not needed. In the doubtful cases, cardiac catheterization is of value. The catheter tip may be inserted into the channel by way of the left pulmonary artery near its origin and thence into the descending thoracic aorta. The oxygen content of the blood in the pulmonary artery is higher than in the right auricle or ventricle due to a shunt of the well oxygenated blood from the aorta to the pulmonary artery. Angiocardiography is seldom used in patent ductus arteriosus.

Interventricular septal defects may be of two types: (1) perforation through the muscle part with a small shunt, and (2) high septal defect located just beneath the semilunar valves which is associated with a large shunt, pulmonary hypertension, dilatation of the pulmonary artery and hypertrophy of both ventricles. In type one, cardiac catheterization and angiocardiography are unnecessary. In type two, cardiac catheterization is of value and shows increased oxygen content in the right ventricle.

Intrauricular septal defects result in a shunt from left to right which increases the pulmonary blood flow resulting in right ventricular enlargement and dilatation of the pulmonary artery. Cardiac catheterization is of value and the tip may go into the left auricle and pulmonary veins and the oxygen content will be higher than in the vena cava. Angiocardiography shows enlargement of the right auricle, right ventricle and pulmonary artery. The left auricle, left ventricle and aorta are of normal size. Opacification of the right chambers and pulmonary artery persists after the left heart has been filled.

Cardiac catheterization is of value in simple valvular pulmonic stenosis and shows a low or normal pulmonary arterial pressure associated with a systolic hypertension of the right ventricle. If, in addition to the stenosis, there is a septal defect without reversal of blood flow, cardiac catheterization could show the defect directly or indirectly by oxygen content of the blood.

(B) The congenital cardiac anomalies of the

cyanotic group may be classified into two major types: (1) severe pulmonary stenosis with septal defect and reversal of shunt from right to left, and (2) severe pulmonary stenosis with a dextroposed aorta with a high interventricular septal defect.

In type one, the septal defect is usually interauricular or there is a patent foramen ovale. Cardiac catheterization and angiocardiography are of great value since a pulmonary valvulotomy rather than a Blalock anastomosis should be performed. Cardiac catheterization shows evidence of pulmonary stenosis by pressure tracings and the interauricular communication directly by the position of the tip of the catheter and indirectly by the oxygen content of the blood. Angiocardiography reveals shunt of the blood from the right to the left auricle, early opacification of the left ventricle and aorta, minimal opacification of the right ventricle and dilated pulmonary artery, and late re-opacification of the left auricle.

The anatomic and physiological variants of type two are numerous. They are dominated by the degree of stenosis and by the degree of overriding of the aorta. The distinction between specific types such as the classic tetralogy of Fallot, pulmonary atresia, pseudotruncus arteriosus, extreme dextroposition of the aorta with common truncus is of value since some clinicians consider that pulmonic atresia is a contraindication to a Blalock-Taussig type of operation and since all agree that the operation is not physiologically feasible in common truncus.

The clinical diagnosis may be simple when the physical signs and roentgen findings are in accordance with the classical description. However, when the findings are not clear, cardiac catheterization and angiocardiography are of value in demonstrating preoperatively whether palliative surgery is indicated and if so to give advance information concerning the technic to be used.

In type two, cardiac catheterization may directly demonstrate the overriding aorta. Pressure tracings can demonstrate the pulmonary stenosis. The septal defect can be shown directly or indirectly. Angiocardiography reveals the essential defect by simultaneous opacification of the aorta and pulmonary artery at the time of opacification of the right ventricle. Poor pulmonary vascular filling can be shown. In case of atresia, the aortic opacification takes place without opacification of the pulmonary vessels.

In the Eisenmenger complex or dextroposition of the aorta without pulmonary stenosis, catheterization of the heart demonstrates the dextroposition of the aorta, the absence of pulmonary stenosis and the interventricular septal defect. Angiocardiographic studies are suggestive but not diagnostic.

The author concludes that only those cases should be studied by cardiac catheterization and angiocardiography in which the diagnosis after careful and expert clinical examination is still in doubt and where a more accurate diagnosis is desired in reaching a therapeutic decision.—*C. W. Cooley, M.D.*

Ernstene, A. Carlton, and Hazard, John B. Extensive calcification of the myocardium; report of a case. *Circulation*, May, 1951, *3*, 690–693.

This is a case report of extensive calcification of the myocardium involving mainly the left ventricle, left auricle and interventricular septum. The patient was twenty-five years of age, with a history of scarlet fever at the age of sixteen, pneumonia at the age of twenty-one and an acute respiratory infection at the age of twenty-three. Physical examination showed cyanosis of the lips and nial beds, distended jugular veins, fluid in the right thorax, enlarged heart, liver, and spleen, but no peripheral edema. Autopsy was performed. No etiological factor was determined, but the probable explanation was a healing phase of a severe toxic or infectious myocarditis.—*J. M. Dell, Jr., M.D.*

Zinn, Willard J., Levinson, David C., Johns, Varner, and Griffith, George C. The effect of angiocardiography on the heart as measured by electrocardiographic alterations. *Circulation*, May, 1951, *3*, 658–662.

The authors quote a mortality rate of 0.4 to 1.0 per cent in angiocardiography as the justification for continuous direct-writer electrocardiography during this procedure. By this means alone could ventricular fibrillation be differentiated from cardiac or respiratory arrest. The development of irritable ventricular foci demonstrable on the tracing would probably preclude a second dose of dye. Premedication with quinidine or procaine-amide appears to lessen the hazards of the procedure. Retrograde aortography may not present as great a cardiac risk probably because less contrast medium contacts the myocardium.—*J. M. Dell, Jr., M.D.*

Fisch, Charles. The heart in dystrophia myotonica. *Am. Heart J.*, April, 1951, *41*, 525–538.

Dystrophia myotonica (myotonica atrophica, Steinert's disease) is a familial disorder of the muscles characterized primarily by slow relaxation after contraction (myotonia) and atrophy. Although the clinical symptoms relate mainly to skeletal muscle, there is some evidence that cardiac muscle may also be involved in the disease. Griffith in 1911 first focused attention upon the cardiac aspects by describing an affected patient who exhibited a marked degree of bradycardia without heart block, apparently secondary to myocardial pathology. Fisch has recently observed 6 patients suffering from dystrophia myotonica, 5 of whom exhibited signs suggesting cardiac muscle affection. The commonest findings were abnormal electrocardiograms (prolongation of the PR interval), hypotension, bradycardia, and generalized cardiac enlargement.

There is no characteristic cardiac contour in the roentgenogram, but cardiac enlargement of the generalized type in a patient suffering from this disease should be considered as possibly one of the manifestations of dystrophia myotonica.—*Harold Fulton, M.D.*

Mullen, Wylie H., Jr., and Geist, Robert M., Jr. The roentgenologic appearance of pericardial calcification. *Cleveland Clin. Quart.*, April, 1951, *18*, 72–77.

Roentgenologically, pericardial calcification is seen just immediately within the heart border and is best visualized on edge. The calcareous encrustations may be observed in any projection; however, those occurring over the right ventricle are best seen in the right anterior oblique position. Left ventricular location of the plaques is visualized best in the left anterior or posteroanterior positions. Deposits in the coronary sulcus can be well demonstrated in either oblique or in a direct lateral view. In each instance it should be projected so that it can be seen tangentially and within the silhouette of the heart.

There may or may not be enlargement of the cardiac silhouette, depending upon the degree of constriction and the layer of fibrous material associated with the calcification. Pericardial calcifications must be distinguished from intracardial or extracardial lesions by rotation of the patient. The calcification is more often over the ventricle. Cases are reported of calcification outlining the auriculoventricular sulcus.

The absence of demonstrable pericardial calcification does not preclude the existence of a noncalcific constrictive pericarditis. Pericardial calcification is unequivocal evidence of pericardial disease. It is the end result of an inflammatory process, frequently tuberculosis.—*V. L. Peterson, M.D.*

Jacobs, Lewis G., and Nussbaum, Herman. Cardiac mensuration as applied to survey films (4×5-inch photoroentgenograms). *Radiology*, May, 1951, *56*, 704–707.

Two hundred adults—134 men and 66 women—without clinical evidence of heart disease were examined by a 14 by 17 inch and a 4 by 5 inch film. All films were measured independently by both authors. It was found that the cardiothoracic ratio (assuming that a heart is enlarged if it exceeds half the chest diameter at the apex of the heart) is an adequate basis for sorting 4 by 5 inch photoroentgen survey films.

This method must not be considered adequate for more precise clinical work, because the procedure is intended for sorting only.—*E. M. Cooper, M.D.*

Sinclair, William J. Congenital short esophagus; review of literature and eight original cases, including one autopsy report. *Arch. Surg.*, April, 1951, *62*, 557–564.

This report contains a review of the general literature of the "short esophagus" and adds 8 original cases. The lesion has long been considered congenital but recently evidence for an acquired etiology has been presented. The theory of an acquired origin postulates the presence of a large esophageal hiatus, either congenital or acquired, which permits a sliding herniation of the stomach into the mediastinum. This displacement interferes with the cardiac valvular mechanism, which is a function of normal position, so that reflux of acid-peptic secretions from the stomach into the esophagus becomes possible despite a normal cardiac sphincter. The inflammation and cicatrization produced by this reflux of gastric secretions are considered capable of producing the shortened esophagus. The congenital short esophagus, as a result of the same mechanism of reflux, is also subject to the complications of acid-peptic digestion. Rotation of the stomach occurs since the lesser curvature is relatively fixed. Angulation at the diaphragmatic opening may result in over-distention of the proximal gastric pouch.

The site of change of the mucosal pattern that characterizes the esophagogastric junction is demonstrable by roentgen examination and accurate placement is possible. The location at the seventh thoracic vertebral level has been remarkably constant in congenital cases. It is believed that shortening may be transient and capable of resolution. Initiation and aggravation of symptoms by emotional tension is becoming increasingly apparent. Prevention of acid-peptic reflux and elimination of mechanical complications are the primary objects of surgical attacks. In one of the reported cases, death was attributed to atelectasis and pneumonia initiated by acute dilatation of the proximal gastric pouch. A previous plastic revision of the esophagogastric junction had permitted acute angulation at the diaphragmatic opening.—*C. N. Borman, M.D.*

Abdomen

Kalk, H. Über die Wehrdienstbeschädigung bei Magenkrankheiten, insbesondere beim Magen- und Zwölffingerdarmgeschwür. (I) (Military service connected disability in stomach diseases, especially gastric and duodenal ulcer. Part I.) *Med. Welt*, April 21, 1951, *20*, 513–516.

The subject of relationship of gastric and duodenal ulcers to military service connected disability in Germany is discussed. The significance of endogenous factors in ulcer formation has been emphasized by the frequency of the disease in many members of a family and in some twins. Yet it is false to look upon ulcer as a pure constitutional disease. World War II has demonstrated as never be-

fore that ulcers are associated frequently with exogenous factors.

Ulcer disease has shown definite increase in civilians during World War II, the incidence of duodenal ulcer being twice and that of gastric ulcer four times greater than before the War. Statistics from other countries have shown a similar trend. In Germany, the clinical picture of ulcers has changed inasmuch as gastric and duodenal defects were larger, the acid value of the gastric juice was lower, the tendency to bleed was greater, and more persons in the older age group were affected. The increased incidence predominated in gastric ulcers, which during the War were three to six times more frequent than duodenal ulcers, while before the War the relation was 1 to 3 to 1 to 5.

The causes of increase in the number of ulcer patients among civilians during World War II may be sought in a greater amount of physical work, irregularity in eating habits, poor protein diet, and marked mental disturbances. Gastric ulcers seem to be more sensitive to exogenous factors while duodenal ulcers are more influenced by mental factors, irregular diet and long periods of hunger. Mental disturbances seemed to produce acute ulcers and especially perforations, as was evidenced during the period of the intense German air attacks on London.

In the Armed Forces, there was likewise an increase in the incidence of gastric and duodenal ulcers during the War. Those branches of the Forces closer to the fighting front had less ulcer patients than did those in the rear area. Seventy per cent of the Armed Forces personnel who had ulcers had manifestation of the disease for the first time after entering the service. It is assumed that since these individuals were mostly young, at which age an ulcer usually becomes first apparent, they would have developed the ulcer even had they been in civilian life. It is concluded that in 85 to 95 per cent of all ulcer patients in the Armed Forces, military service had no influence on the formation of the disease. This was not true of gastritis, the incidence of which was four to eight times greater as compared to the prewar period. However, in the presence of an existing ulcer, the possibility of a recurrence is enhanced by military duty.

Liver damage due to hepatitis, hunger, dystrophy, chronic infections, etc., may play a factor in formation of peptic ulcers. The role of head and brain injuries in relation to ulcers is discussed. Of 342 such patients followed up to three years, only 5 cases of peptic ulcer were found, 3 of which had the disease prior to the injury.

Two phases are distinguished in discussing the development of peptic ulcer: the onset and the chronic persistence of the ulcer. The author believes that acute ulcers often arise and heal quickly. Special factors, sometimes exogenous in nature, are necessary to produce the chronic ulcer. In the majority of cases, however, an endogenous factor, that is, the "ulcer constitution" is also necessary.—*Samuel Richman, M.D.*

Kalk, H. Über die Wehrdienstbeschädigung bei Magenkrankheiten, insbesondere beim Magen- und Zwölffingerdarmgeschwür. (II). (Military service connected disability in stomach diseases, especially gastric and duodenal ulcer. Part II). *Med. Welt*, April 28, 1951, *20*, 557–560.

The author discusses how one should evaluate an individual in whom a proved peptic ulcer has become manifest for the first time while in military service. On the one hand, it is certain that exogenous factors do influence the development of the ulcer (studies on civilians have demonstrated this), and that there are factors in military life which also affect the stomach adversely (the high frequency of recurrence). On the other hand, the significant role of a constitutional tendency in ulcer genesis even in the military personnel cannot be denied. Certain criteria may be of aid in deciding in the individual case the role of the exogenous and the endogenous factor played in the causation of the ulcer, as for example, a history of ulcer in the family, frequency of ulcer in relatives, the occurrence of ulcer in an unusually young individual, etc. Ulcers, which arise during the normal activity of civilians or in the rear echelon of the military, undoubtedly are on a constitutional basis. However, certain exogenous factors may be contributory, such as long military campaign accompanied by hunger, unusual physical fatigue, mental disturbances and the absence of immediate medical care. Thus, there is no other choice than to recognize that in a given case of proved ulcer which arose during military duty, a service connected disability exists whenever this military duty entailed severe hardships. This is more of a legal than a medical decision since the author is convinced that from a medical point of view, even with the above mentioned restrictions, far too many ulcers are diagnosed as service connected.

Treatment must be directed to cause complete disappearance of the ulcer. This is done best with bed rest and strict diet. If the ulcer heals, and no functional symptoms remain, the question of service connection is settled. If, however, the patient develops a recurrence after he has become a civilian, then his ulcer is definitely not service connected, since due to his "ulcer constitution" he would have developed an ulcer even without military service. When the healing of the ulcer is followed by changes in the pylorus, shortening of the lesser curvature of the stomach, hour-glass stomach, or deformity of the duodenal bulb, the likelihood of a recurrence is great. Such cases must be considered service connected, in spite of a "constitutional tendency" to ulcer function. In the majority of gastric ulcers, healing is prompt and complete and service connection is not considered.

In duodenal ulcers, owing to functional disturbances secondary to fibrotic bulb deformities, the prognosis is less favorable and there is a greater tendency to recurrence of the ulcer. For this reason, disability must be considered permanent. Since the symptoms of duodenal ulcer are periodic in nature, the degree of disability is evaluated at 30 to 40 per cent, unless complications such as stenosis, perforation or frequent gross hemorrhage occur. In view of the fact that medical care of a patient in the front line is often delayed and apt to be less thorough as compared to that in the rear echelon, one should be more generous with the front-line soldier when considering service connected disability. If a patient has had ulcer symptoms before the war and he develops a recurrence during military duty, that recurrence is service connected. If the recurrence appears after separation from military duty, it is assumed to be a natural sequence of the disease and is not considered service connected.

Following operative intervention, it is impossible to evaluate the symptoms in any ulcer patient. The question of service connection in such instances cannot be considered too seriously since a stomach once operated upon can be a source of many symptoms.

The relation of trauma to ulcer formation is also discussed. Generally, ulcers do not occur after trauma to the abdomen. Yet there are cases in which stomach symptoms appeared immediately after the injury and then, within hours, a perforation of a typical ulcer occurred. These are rare instances and must be considered service connected. There are reports of development of gastric and duodenal ulcers following trauma to the vertebral column and spinal cord, especially in the region of D_5 to D_{10} (thoracic segments supplying the stomach). Finally, peptic ulcers have been observed to occur after severe burns and freezing.

Gastritis was found frequently in the military personnel, particularly in the front-line soldiers and aviators undergoing great stress. No service connected disability is allowed in this disease, except in the rare cases which were exposed to prolonged injury and which could not get immediate treatment, so that a chronic gastritis with achylia resulted. One may also include in this group the cases of gastritis following severe chronic infections and dysentery.—*Samuel Richman, M.D.*

Moreau, Marcelo H. Contribución a la exploración radiológica del fundus gástrico. (Contribution to the roentgenological examination of the fundus of the stomach.) *Radiología*, Buenos Aires, March, 1951, *12*, 22–28.

The author recommends that the following two positions be included among the standard positions for the roentgen examination of the fundus of the stomach:

(1) Frontal position. The patient lies in dorsal decubitus, the cassette is placed under his back and the central ray is directed either perpendicular to the cassette or at an oblique angle towards the feet. The author prefers this latter modification since it permits a visualization of a greater part of the vertical portion of the stomach at the same time.

(2) Lateral position. The patient is in dorsal decubitus, the cassette is placed vertically against his left side and the central ray is directed horizontally, perpendicular to the cassette. In this position a good filling of the gastric fundus is obtained.

Both positions are of considerable aid in visualizing intrinsic lesions of the fundus, pressure effect from surrounding organs and the presence of diaphragmatic hernia of the stomach. Numerous roentgenographic reproductions are used to illustrate the various findings.—*T. Leucutia, M.D.*

Presno Albarrán, J. A., Acosta Montejo, J. A., Balandrín Castellanos, M. S., and Ponce de León, F. Ulceras múltiples gastroduodenales. (Multiple gastroduodenal ulcers.) *Arch. Hosp. Universitario*, Habana, Nov.–Dec., 1950, *2*, 687–707.

This aspect of ulcer seems to have received little attention as manifest by the dearth of existing bibliography. Statistics are variable and there is marked disparity between the reports of pathologists and clinicians. A review of the literature (34 references) indicates that the incidence of chronic multiple gastroduodenal ulcers is 5 to 10 per cent of chronic ulcers in general. The authors have encountered 29 cases of multiple ulcers, representing 27 per cent of chronic ulcers. Most of these were multiple in the duodenum.

Symptoms of long standing with rare remissions are among the factors serving as indices of suspicion of multiple ulcers.

Roentgenologically, some cases are easily diagnosed when ulcers are located in both the stomach and the duodenum, or when more than one ulcer is located on the lesser curvature of the stomach. The roentgen diagnosis of multiplicity becomes more difficult when the ulcers are confined to the duodenum itself. When an ulcer of the gastric antrum is surrounded by smaller satellites, the mutiplicity is likewise more difficult to diagnose.

The authors made a correct diagnosis of multiple ulcers in 80 per cent of those cases found to be multiple by the surgeons.

A case with six gastroduodenal ulcers is presented. —*Norman Simon, M.D.*

Noguera, Oscar, Barragué, Jorge E., and Caussi, Manuel J. Prolapso de la mucosa gástrica en el bulbo duodenal. (Prolapse of the gastric mucosa into the duodenal bulb.) *Radiología*, Buenos Aires, March, 1951, *12*, 10–15.

Prolapse of the gastric mucosa into the duodenal

bulb is a little known nosographic entity although it is encountered not infrequently in patients with atypical pseudo-ulcer symptoms.

The condition was first recorded by von Schmieden in 1911 but the criteria of roentgen diagnosis were not established until 1925 when Elliason, Wright and Pendergrass published their observations. Experience gained during the last few years places the responsibility for recognizing duodenal prolapse of the gastric mucosa primarily on the radiologist.

According to the authors, prolapse of the mucosa of the antrum through the pylorus may occur under two circumstances: (1) in pedunculated lesions of the antrum, such as polyp or polypoid gastritis, the peristaltic contractions may force their extrusion into the duodenum, and (2) in simple prolapse the antral mucosa becomes detached from the deeper layers and slips through the pylorus into the duodenal bulb. This schematic classification does not exclude mixed forms in which the mucosa of polypoid formations is carried forward by the peristalsis.

The diagnosis is essentially roentgenologic. The characteristic findings may be placed into three categories: (a) antral signs, consisting of hypertrophic or polypoid gastritis with marked thickening of the mucosal folds and verrucous formations of the hyperplastic structures; (b) pyloric signs, consisting of elongation of the pyloric canal which contains several mucosal folds of varying size and configuration, usually running without interruption from the antrum into the duodenum; and (c) bulbar signs, consisting of a filling defect which begins at the base of the duodenal bulb and extends to part or the whole bulb, depending on the volume of the prolapsed mucosa and the degree of the engorgement produced. The deformity often varies during the same study or in successive examinations.

The authors reproduce typical roentgenograms to illustrate (a) the antral manifestations due to local hypertrophic gastritis, (b) the modifications of the pyloric canal resulting from sliding of the prolapsed mucosa into or through the canal and (c) the filling defects which are produced in the duodenum by the bulbous end of the projected mucosa and which are commonly called "mushroom" or "parachute" images. They also include 2 cases in which the antral polyps slipped into the base of the duodenal bulb.

The differential diagnosis includes simple hypertrophy of the pylorus in the adult, associated with constant elongation and narrowing of the pyloric canal; polyps or papillomas of the base of the bulb, and duodenal ulcer which may occur simultaneously with a polapse.

Although medical management may lead to temporary improvement, radical surgery is recommended as the treatment of choice.—*T. Leucutia, M.D.*

Reussi, Carlos, Gozzi, Héctor D., and Rigoli, Mario H. Prolapso de la mucosa gástrica en el duodeno. (Prolapse of the gastric mucosa into the duodenum.) *Prensa méd. argent.*, May 25, 1951, *38*, 1277–1283.

The frequency of prolapse of the gastric mucosa into the duodenum is variously quoted as 0.1 to 1.0 per cent. It is found between the ages of twenty-eight to eighty years but is most frequent in the fourth decade.

Numerous theories have been suggested as to etiologic factors. Elliason and Wright considered hypertrophic gastritis as the essential predisposing cause, the large folds being carried toward the duodenum by a peristaltic wave. Rees studied 3 cases treated surgically and thought that there was a loss of muscle substance in the involved area, resulting in fibrous tissue reaction. This produced stenosis which led to more active peristalsis. This in turn could lead to a debilitation of the attachment of the muscular and mucosal layers, thus facilitating movement of the mucosa. Other investigators have considered the principal etiologic agent to be a peptic ulcer at the base of the duodenal bulb or prepyloric region. Scott described 5 cases treated surgically and found no evidence of pre-existing organic disease. He thought the condition could be due to alteration of the gastric peristalsis, commonly influenced by emotional factors.

Clinically the patient's history is that of an atypical peptic ulcer or of recurrent gastric difficulties, some of which are functional. Cramping pain is the most frequent symptom. There may be nausea and vomiting, anorexia, loss of weight, anemia, hematemesis or melena. In several cases the condition was discovered incidentally occurring in conjunction with numerous types of diseases of the gastrointestinal tract.

The roentgenologic examination reveals narrowing of the distal antrum, with retention of structure of the mucous membrane. The appearance suggests an elongated pylorus. There is also a filling defect in the base of the duodenal bulb which varies in size according to the degree of prolapse of the mucosal folds. The condition must be differentiated from all other diseases of this immediate region including gastric carcinoma, peptic ulcer, hypertrophic pyloric stenosis of the adult, antral gastritis, benign tumors, and duodenitis.

The treatment is usually conservative, surgery being indicated in cases of persistent pain, hemorrhage, or obstruction.—*C. M. Nice, M.D.*

Garcia, Manoel F., and da Costa, J. Nunes. Prolapso da mucosa gástrica. Apresentação de 11 casos diagnósticados radiológicamente, Revisão da literatura. (Prolapse of the gastric mucosa; presentation of 11 roentgenologically diagnosed cases; review of literature.) *Rev. brasil. gastroenterol.*, May–June, 1951, *3*, 283–304.

The authors give a tabular compilation of 200 cases of prolapse of the gastric mucosa which they were able to collect from the world literature, including the 11 cases of their own. These cases were reported in 33 articles by 58 investigators, beginning with the first publication of von Schmieden in 1911. The distribution according to the various countries was as follows: Argentine, 5 cases; Belgium, 10 cases; Canada, 2 cases; Denmark, 2 cases; Germany, 1 case; Sweden, 6 cases; United States of America, 163 cases; and United States of Brazil, 11 cases. The incidence among patients examined roentgenologically for gastric complaints was given as varying between 0.1 and 2.8 per cent. In the authors' own series it was 0.78 per cent.

Although this exhaustive review would seem to indicate that prolapse of the gastric mucosa is very rare, the authors believe that the condition can be detected more frequently if diligently searched for and especially if the early and moderately advanced forms are also taken into consideration. The fact that most of the cases in the literature have been reported since 1946 tends to support such a view.

The most important means of diagnosis is the roentgenologic examination. The authors distinguish between three stages of the prolapse of the gastric mucosa.

(1) In the first stage, which is the most frequent, a single mucosal fold is visualized in the pyloric canal. This fold starts from the upper or lower prepyloric region and runs into the canal. There is a very discrete deformity of the base of the duodenal bulb, resembling the picture of an "open umbrella."

(2) In the second stage, one or several thickened mucosal folds are projected into the pyloric canal which now appears elongated. The deformity of the base of the duodenal bulb is also more pronounced, exhibiting more clearly the "open umbrella" appearance, although in certain cases the distortion may be more marked on one side.

(3) In the third stage, which is encountered very rarely, the detached prepyloric mucosa with its plainly visible folds has completely slid through the pyloric canal giving the impression of a miniature intussusception. The pyloric canal is elongated and narrowed. Frequently the duodenal bulb contracts on the propelled mucosa, permitting only a small amount of barium to pass through, which then gives rise to the characteristic "mushroom" appearance with the head in the duodenal bulb and the stalk in the pyloric canal.

A gastroscopic examination was done in 7 of the authors' 11 cases. The prolapsed gastric mucosa could not be seen in one single instance, but the demonstration of hypertrophic antral gastritis in 4 cases was helpful supporting evidence.

The treatment in 10 cases was conservative, consisting of bland diet, avoidance of emotional strain and the administration of antiacids, antispasmodics and antihistamines. One patient with recurrent gross hemorrhages, was subjected to gastrectomy. The authors recommend that surgical intervention be undertaken only in the presence of complications.

The 11 cases are reported in detail and richly illustrated with roentgenographic reproductions.—*T. Leucutia, M.D.*

Gottlieb, Charles, Beranbaum, Samuel L., and Dorfman, Milton. Roentgen features of non-malignant periappendiceal and ileocecal lesions. *Am. J. Digest. Dis.*, March, 1951, *18*, 79–86.

The roentgen difficulties in distinguishing between inflammatory and neoplastic lesions of the ileocecal region are well known. A knowledge of both the normal anatomy and physiology of the cecum, terminal ileum, ileocecal valve and appendix are helpful in differential diagnosis by roentgen examination.

A filling defect of the cecum is not pathognomonic of a malignant lesion as is commonly considered. Several cases are reported in which both a filling defect and an associated palpable mass were present, and were due to cecal or pericecal inflammatory disease. The authors state that the most common inflammatory filling defect in this region is produced by an appendiceal abscess. This defect is usually smooth, distinct, eccentric in location and involves the medio-inferior aspect of the cecum. The mucous membrane pattern is normal. This contrasts with the filling defect due to a neoplasm which usually shows narrow canalization, shelf formation and destruction of the mucous membrane.

Regional ileitis produces various changes in the ileocecal region, depending upon the state of the pathologic process. Early there may be slight encroachment on the lumen of the terminal ileum and disturbance of the mucous membrane pattern. Later, rigidity, narrowing and ulceration occur. Concomitant changes in the cecum due either to spasm, extrinsic pressure from an inflammatory mass or definite inflammatory disease of the cecum itself may be noted. The multiplicity of lesions, the greater length of the individual lesion, involvement of both the cecum and ileum and the serrated mucosal markings should suggest inflammatory disease rather than malignancy.

Tuberculosis of the bowel usually starts in the ileocecal region and produces changes which may be indistinguishable from regional ileitis or malignancy. The simultaneous involvement of the cecum and terminal ileum, the narrowing and rigidity of the terminal ileum and the associated mucosal changes all point toward an inflammatory process.

Amebic cecitis, rarely associated with similar involvement of the terminal ileum, simulates idiopathic ulcerative colitis roentgenologically and may closely simulate malignancy. The presence of a smooth filling defect and the demonstration of

parasites in the stool are important in establishing a correct diagnosis.

Hypertrophy of the ileocecal valve and ileal prolapse into the cecum are other benign conditions which must be distinguished from malignancy in this region. They usually occur together and the presence of a smooth round defect intimately associated with the ileocecal valve, the change in size and shape which may occur and the absence of obstruction are important features in identifying these normal variations.

The roentgen features must be closely correlated with the clinical findings and even then the differentiation between an inflammatory and neoplastic mass in the ileocecal region can be extremely difficult and at times impossible.—*Gerald Lavner, M.D.*

Casal, Manuel A., García, Manuel Lemos, and Cóppola, José A. Invaginaciónі leocecal por cáncer. (Ileocecal invagination due to cancer.) *Prensa méd. argent.*, Jan. 19, 1951, *38*, 140–142.

A case of ileocecal invagination due to cancer of the cecum, proved by roentgenological and pathological examination is presented.

A fifty-four year old woman had right lower abdominal pain for two months and then developed clinical symptoms of intestinal obstruction. A fist-sized mass was palpable in the right lower quadrant. Barium enema examination showed obstruction of the ascending colon by intussuscepting intestine. At operation an ileocecal resection was made for carcinoma of the cecum.

At the National Institute of Gastroenterology of Buenos Aires, 12 cases of intussusception in adults have been registered in the past ten years. Of these, 9 have been ileocecal, 6 due to inflammation (chronic appendicitis, tuberculoma of the cecum, etc.) and 3 due to neoplasm. There has been 1 case each due to solitary polyp, multiple polyps and carcinoma of the cecum.—*Norman Simon, M.D.*

Culver, Gordon J., and Caldwell, Milton V. Endometriosis of the recto-sigmoid. *J. Canad. A. Radiologists*, March, 1951, *2*, 6–11.

The authors define an endometrioma as a tumor containing aberrant endometrium, or a tissue resembling endometrium, which responds to some of the stimuli which affect normal endometrium. Endometriosis clinically occurs in about 15 per cent of all women during their active menstrual life, and one-fourth of the patients with pelvic endometriosis have involvement of the rectosigmoid. Of this group about one-half are symptomatic.

Roentgen evidence of endometriosis may be classified in two groups, constricting and non-constricting. The portions of bowel with mesentery are less likely to show obstruction than the extraperitoneal and more firmly attached bowel. Two factors aid in production of obstruction: (1) the tumor may encroach upon the lumen, and (2) associated inflammatory reaction produces spasm.

In constricting lesions, the barium enema study may show, (1) annular narrowing of variable length, (2) sharp demarcation of area involved, (3) fixation and tenderness of lesion, and (4) preservation of mucosal folds.

In non-constricting lesions, the findings are (1) presence of a submucosal tumor with normal mucosa overlying it, (2) spasm and irritable segment above and below the lesion, (3) local tenderness of lesion, (4) variation in size of lesion with menstrual cycle.

Differential diagnosis is between malignancy and diverticulitis. In the former there is mucosal destruction, lack of tenderness and lack of variation in size. In diverticulitis, signs of infection are usually present, diverticula may be demonstrated, and the lesion is long with evidence of spasm above and below it.

The authors present the clinical and roentgenographic findings in 2 cases proved by surgery. The first case showed complete obstruction to retrograde barium flow and intact mucosa; the second case was remarkable by roentgen demonstration of change in size of mass with change in menstrual cycle.—*I. R. Berger, M.D.*

Gerwig, Walter H., Jr., and Thistlethwaite, J. Richard. Cholecystitis and cholelithiasis in young women following pregnancy. *Surgery*, Dec., 1950, *28*, 983–996.

The authors report 10 cases of women less than thirty years of age having cholecystitis and cholelithiasis whose symptoms began during or after a pregnancy, all of whom were operated on within a six month period. Although disease of the biliary tract is generally recognized to occur most frequently among obese women in the fourth and fifth decades of life, in all of the authors' cases the patients were much younger and slender or of normal build. The symptoms were not unusual, pain being the predominant complaint in all instances. Six patients were admitted during attacks of severe biliary colic. Symptoms began during or after the first pregnancy in 6 cases, after the second pregnancy in 3 cases and after the sixth in 1 case.

Roentgenologic examination of the gallbladder revealed evidence that the organ was non-functioning in 7 of the 10 cases. In some of these, the stones contained enough calcium to be visible on the roentgenogram. In the 3 cases in which function was present, calculi were demonstrated.

At operation, calculi were found in all instances. The pathologic changes in the wall of the gallbladder varied from 1 to 4 plus, 1 being the least change and 4 being the greatest. All calculi contained cholesterol.

Calculi of pure cholesterol were found in 3 cases, of layered cholesterol-calcium in 2 cases and of cholesterol-pigment-calcium in 5 cases. In 5 cases the cystic duct was completely obstructed.

The results were uniformly good. In the authors' opinion, this was attributable to the fact that pain in all cases was a result of disease of the biliary tract, and that all patients were in a young age group in which there were no associated complications.

The authors advocate early operation, thereby preventing the associated cholangitis and hepatic damage resulting from long-standing inflammation. —*P. G. Dillard, Jr., M.D.*

Allison, P. R. Reflux esophagitis, sliding hiatal hernia, and the anatomy of repair. *Surg., Gynec. & Obst.*, April, 1951, *92*, 419–431.

A syndrome of heartburn, gastric flatulence and postural regurgitation is described and the syndrome is attributed to reflux esophagitis. This may be caused by incompetence of the gastro-esophageal junction due to a sliding hernia of the stomach through the esophageal hiatus of the diaphragm into the posterior mediastinum. If the roentgenographic examination is carried out with the patient in the Trendelenburg position and with pressure applied to the abdomen, the herniated part of the stomach may be distended with barium and easily demonstrated. If the patient is fluoroscoped while standing and bending forward as if to touch her toes with her fingers, barium will be seen to flow back from the stomach into the esophagus and pharynx as easily as it passed down.

By direct endoscopic examination the esophagus shows a characteristic set of changes. The mucous membrane is pinker and thicker than usual and may appear to have redundant folds which slightly impede the passage of the instrument. Toward the lower third the mucosa may be much more inflamed so that it bleeds easily on contact with the esophagoscope and ulcers usually of 2 to 3 mm. may be seen. The esophagoscope passes from the esophagus into the stomach pouch without deviation and without the obstruction of the diaphragmatic pinchcock.

It is stressed that with a sliding hernia it is the irritation of the esophagus which causes the symptoms and that ulceration, when it occurs, is dependent upon the anatomical derangement of the cardia. Therefore, the aim of surgery must be to restore to normal those factors which are responsible for the protection of the esophagus. This is achieved by two main steps: (1) by division of the extended phrenoesophageal ligament and peritoneal reflection close to the cardia and the resuturing of these to the under aspect of the diaphragm, and (2) by application of the vertical fibers of the right crus to one another behind the esophagus and their retention by such light suturing as will enable them to continue to act as muscle.

Summary. The records of 204 patients with diaphragmatic hiatal hernia occurring in a thoracic surgical unit over a five year period are reviewed.

The results of operative treatment in 33 patients with sliding hiatal hernia and superficial esophagitis are presented together with the results in 15 who had progressed to stenosis and required resection.—*Mary Frances Vastine, M.D.*

Fierst, S. M., Robinson, H. M., and Lasagna, L. Interstitial gastric emphysema following gastroscopy; its relation to the syndrome of pneumoperitoneum and generalized emphysema with no evident perforation. *Ann. Int. Med.*, May, 1951, *34*, 1202–1212.

The authors review the literature on 6 cases of pneumoperitoneum without evident perforation following gastroscopy and add 1 case of their own.

In all the cases the gastroscopic examination was unsatisfactory because of collapse of the stomach. The pulse, temperature and respirations were normal in all of the cases. Most of them had signs of pneumoperitoneum with a feeling of distention. Four patients showed varying degrees of emphysema involving the mediastinum, retroperitoneum, scrotum, and tissue of the neck. At operation there was no evidence of perforation of the stomach or abdominal esophagus.

The authors suggest that the mechanism for the extravasation of air is through a weak point in the mucous membrane into the perivascular sheaths; from here to the serosa, then along the peritoneal reflections of the stomach. The air infiltrates the gastrohepatic ligament and the omentum which ruptures into the peritoneum.

It is suggested that pneumoperitoneum and generalized emphysema without systemic manifestations may be treated without surgical intervention.—*F. H. Squire, M.D.*

Butler, T. J., and Capper, W. M. Experimental study of 70 cases showing the early post-gastrectomy syndrome. *Brit. M. J.*, May, 1951, *1*, 1177–1181.

The authors investigated the so-called "post-gastrectomy syndrome" from the experimental point of view, choosing their patients from 660 who had survived partial gastrectomies for benign peptic ulcer. Seventy-nine of these patients showed the early post-gastrectomy syndrome. The symptoms were those of epigastric fullness and distress, pallor, sensation of warmth, nausea, palpitation, and vomiting. The patients were studied using a Miller-Abbott tube which allowed distention of the jejunum and distention of the remaining portion of the stomach.

The authors conclude that the sensation of abdominal fullness is due to distention of the jejunum

and can be produced by the presence of a distended balloon. The vasomotor component can be completely reproduced by inert substances in the stomach, such as barium or mercury bag, and appear to be the result of downward tugging. In the supine position the heavy mercury bag in the somach fails to produce vasomotor symptoms. Posture has no effect on the sensation of fullness produced by the distended balloon in the jejunum.

There was no correlation between the blood sugar curve of patients with and without symptoms.

Splanchnic block relieved the symptoms in most cases, suggesting that they are transmitted through the sympathetic nervous system.—*C. L. Hinkel, M.D.*

Gynecology and Obstetrics

Pollock, Mary, and Preiskel, Ella. Hysterosalpingography with a water-soluble medium in the investigation of infertility. *J. Obst. & Gynaec. Brit. Emp.*, June, 1951, *58*, 421–426.

This is a report of a study of 310 patients who were examined by hysterosalpingography in which water-soluble (35 per cent) diodone was employed. The authors prefer this medium because it is rapidly and completely absorbed from the peritoneal cavity and does not act as a foreign body or nidus for infection. If intravasation occurs, there is no danger of pulmonary oil embolism. By rapid injection they were able to obtain a more detailed study of tubal structure and tone.

The examination was diagnostic in 274 cases (88 per cent) and inconclusive in 15 (5 per cent). Failure occurred in 11 cases (3 per cent).

Of the cases considered diagnostic, 107 (39 per cent) were normal. Fibroids, endometrial irregularities and increase in length of the cornua occurred in 30 cases (11 per cent). Cornual occlusion was noted in 47 cases (17 per cent), isthmic occlusion in 27 cases (10 per cent) and fimbrial occlusion in 62 cases (25 per cent). Fimbrial occlusion with hydrosalpinx occurred in 41 cases (15 per cent). Ampullary tubal dilatation or atony was observed rather frequently (25 cases) in the present series.

It is believed that diodone is more irritating to the pelvic peritoneum than lipiodol. Transient pain in the lower back or abdomen was noted in 20 per cent of patients. Three patients complained of severe pain. Two patients fainted upon arising from the table. These reactions were considerably diminished if pethedine was given before the examination.—*J. N. Ané, M.D.*

McElin, Thomas W., Lovelady, Sim B., Brandes, Robert W., Hunter, James S., Jr., and Good, C. Allen. A preliminary evaluation of Cave's roentgenographic method of fetal cephalometry. *Am. J. Obst. & Gynec.*, March, 1951, *61*, 487–497.

The literature regarding fetal cephalometry is extensively reviewed preliminary to a report of the authors' experience in 22 cases using Cave's method. In 1943 Cave described a relatively simple method of measuring the fetal head from roentgenograms. The method consists of making a roentgen exposure with the tube centered over the fetal skull with a known distance of the tube from the film. Then a second exposure is made with the same centering and as soon as possible after the first film but with a different known tube film distance. The resulting images are measured and applied in a simple formula which then gives the actual length of the diameter under consideration.

From a study of the 22 cases using this method, the authors conclude that it is unreasonable to expect a high degree of accuracy in roentgen cephalometry when it is realized that it is an attempt to measure variables within a very small range by an indirect method. They think such measurements to be of value in the primigravid woman with a questionable pelvis form when a trial of labor is contemplated and excessive fetal size is suspected. They believe that if grossly unsatisfactory roentgenograms are excluded accurate diameters of the fetal skull in the uterus to within ±6 per cent can be obtained by Cave's method in 85 per cent of the cases.—*J. H. Harris, M.D.*

Genitourinary System

Budniok, R. Über einen Fall von Luftembolie durch ein Pneumogramm der Harnorgane in Peridural-Anästhesie. (A case of air embolism during pneumography of the urinary tract under spinal anesthesia.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, March, 1951, *74*, 348–349.

Pneumourograms were used rather extensively in Germany during the war years because of scarcity of contrast media. Many authors have reported using this method without complications or death.

The author reports in detail a case of fatal air embolism following this procedure. Fifteen cubic centimeters of air were injected under spinal anesthesia; immediately after this injection the patient became cyanotic and died. Postmortem examination showed air in the heart. The author presumes that the dilatation of the blood vessels of the kidneys caused by the spinal anesthesia may have been responsible for the embolism and warns against using air urography under spinal anesthesia.—*H. W. Hefke, M.D.*

Orlandini, Ivo. Studio anatomo-radiografico delle alterazioni vasali in alcune forme patologiche del rene. (An anatomical roent-

genographic study of alterations of blood vessels in certain forms of renal pathology.) *Ann. radiol. diag.*, 1951, *23*, 125–146.

The author has investigated the pattern of the branches of the renal artery both in the normal and pathological kidney. The material consisted of kidneys removed from living patients and cadavers.

He has developed an opaque medium which solidifies when injected into the renal artery of the kidney fixed in formalin, thus preventing its dispersal into the tissues. This technique permits roentgenography of the kidney, either intact or in sections.

In the normal kidney, the renal artery divides into smaller branches to form arcuate arteries which in turn subdivide into the interlobar arteries. A less common form is one in which the arcuate arteries are absent and the interlobar arteries divide and subdivide within the parenchyma of the kidney. In either case the subdivisions of the interlobar arteries are evenly distributed throughout the kidney cortex in a regular pattern.

In the pathological kidney studied by this method the arterial pattern was found to be sufficiently altered and the changes noted were so characteristic of the pathology that each entity could be distinguished from one another. This was especially true in the case of polycystic kidney and solitary cyst of the kidney.

The purpose of this study was not to minimize the importance of intravenous or retrograde pyelography but rather to furnish some basic information concerning the pattern of the renal arterial tree for better understanding and interpretation of aortograms.—*P. E. Russo, M.D.*

Greene, Laurence F., and Rosenthal, Macey H. Multiple hypernephromas of the kidney in association with Lindau's disease. *New England J. Med.*, April 26, 1951, *244*, 633–634.

Lindau reported in 1926 that 20 per cent of patients with angiomatosis of the retina have intracranial complications consisting of cysts or angioblastic tumors in the cerebellum or medulla oblongata. In addition to the intracranial tumors, cysts of the pancreas and cysts or hypernephromas of the kidneys not infrequently occur. Lindau considered the tumors of the kidney to be of a benign hypernephroid type. They may be malignant, however, as shown by Kernohan.

The authors present a case in which a diagnosis of Lindau's disease was made in 1938. A cerebellar craniotomy showed a hemangioendothelioma of the left cerebellar lobe. The urine was normal at that time.

In 1946 a mass was found in the right upper quadrant of the abdomen. Urologic and roentgenographic studies showed it to be an enlarged right kidney. The pelvis and calyces were dilated and the lower calyx was deformed by a mass. Urinalysis showed a pyuria. A right nephrectomy was done and a hypernephroma was found in the lower pole and also a smaller hypernephroma in the upper pole of the kidney.

The patient was well four years after the nephrectomy and twelve years following the diagnosis of Lindau's disease. Pyelographic studies showed the left kidney to be normal.—*C. W. Cooley, M.D.*

McCahey, James F. Bilateral surgical renal disease. *Urol. & Cutan. Rev.*, March, 1951, *55*, 144–146.

Bilateral surgical renal disease may be divided into two groups. In the one group, both kidneys are simultaneously affected by the same disease producing agent. In the other group, the kidneys are diseased separately. In this article, the author discusses examples and case reports of both groups. The first group includes a variety of conditions including congenital anomalies, systemic infections, urinary tract obstructions and certain types of uremia.

In the second group, the author notes 10 cases wherein separate disease involving each kidney required one or more operations. A discussion of the etiology of the urinary tract disease in these 10 cases is briefly given.—*G. W. Chamberlin, M.D.*

Doss, A. Keller, and Quirarte, Humberto A. Evaluation of the surgical kidney employing translumbar aortography. *Urol. & Cutan. Rev.*, March, 1951, *55*, 134–141.

The emphasis in this article is placed upon an evaluation of the blood supply to the kidney as a method of prognosis. There are certain technical difficulties which prohibit perfect roentgenographic visualization as a routine procedure. However, in the technically correct study, one should look for the relative size of the two renal arteries, duplication of arterial supply, position of the renal arterial tree with respect to the surrounding structures, large and small intrarenal vessels and the nephrogram.

In the absence of malignant disease, a preoperative opinion may be arrived at as to whether one should do a nephrectomy in a given case. Occlusion of the main arterial tree, appreciable reduction in the number of large intrarenal vessels or absence of the small intrarenal vessels may indicate the need for a nephrectomy. Aortography is not a substitute for the customary roentgenographic and other procedures for study of the urinary tract. In certain instances, however, it may be a valuable supplementary procedure to use.—*G. W. Chamberlin, M.D.*

Fischmann, Joseph. Two extreme forms of autonephrectomy in renal tuberculosis. *Brit. J. Urol.*, March, 1951, *23*, 52–55.

Two cases of autonephrectomy in tuberculosis of

the kidney are reported. It is pointed out that this condition is rarely diagnosed during life, and is usually found at autopsy. These 2 cases showed a non-functioning kidney with renal calcification. The kidneys were removed and the diagnosis confirmed by histopathological examination of the removed organs. Case histories are presented.—*D. S. Kellogg, M.D.*

Adams, A. Wilfrid. The aberrant artery—its division or conservation in hydronephrosis. *Brit. J. Urol.*, March, 1951, *23*, 6–22.

The author discusses the role of the aberrant artery in the genesis of hydronephrosis, and the relative merits of arteriotomy and nephroplication in the treatment of this condition. Nephroplication was described by Hamilton Stewart in 1947. He considers that one of the objections to arteriotomy as a standard procedure is that division of the taut vascular bundle does not answer the need of the majority of cases. His contention is that most cases reach one at a mature age, and with passing years the acute "S" bend of the ureter becomes fixed by plastic inflammation around the site of stress. Mere section of the taut artery is semi-effective in the established case.

The first step in nephroplication is to free the ureteropelvic junction from the compressing vessels and fibrous fusion. Secondly, recurrent strangulation of the ureter is prevented by lifting the lower pole, carrying the obstructive vessels with it to the upper pole of the kidney. The kidney is folded, belted, and returned to its bed with urinary channel and blood supply preserved intact.

The author reports briefly on 14 consecutive cases of nephroplication in 13 patients. He considers 11 patients clinically cured and 1 improved. Nephrectomy has been necessary in 1 case because of infection. One patient, with congenital solitary kidney, developed uremia after the operation. Nephrostomy was done and the patient eventually recovered without sepsis. This case would seem to support the idea that renal resentment to the insult may be profound yet ordinarily masked by the function of an opposite healthy kidney.

Inferior polar arteriotomy is a simple procedure, and may occasionally be the operation of choice in the very young. Stewart's operation of renal decompression, preserving blood supply and urinary passages inviolate, has been tried and proved effective. A few more years must elapse to prove the permanency of the remedy.—*D. S. Kellogg, M.D.*

Nesbit, Reed M., and Baum, William C. Serum phosphatase determinations in diagnosis of prostatic cancer; review of 1,150 cases. *J.A.M.A.*, April 28, 1951, *145*, 1321–1324.

In this paper the authors carefully analyze the importance of serum phosphatase determination in a collected series of 1,150 proved cases of prostatic carcinoma. Only the epithelial cells of the prostate and prostatic carcinoma cells produce the acid phosphatase enzyme in significant amounts. The sustaining influence of the male sex hormone is necessary for continued production of this enzyme. Elevations of serum acid phosphatase are not observed in prostatitis, benign prostatic hypertrophy or tumor metastases to the prostate from other organs. Transient elevations of the serum titer have been observed after trauma to the prostate gland but it is well established that sustained abnormal elevations are pathognomonic of metastatic carcinoma of the prostate.

Alkaline phosphatase is produced by bone and reflects bone activity in the absence of liver disease. It is not specific for prostatic carcinomatous activity. Elevation of serum alkaline phosphatase titer in presence of known metastatic carcinoma of the prostate indicates the extent of osteoblastic response to the invading tumor. This enzyme provides a useful clinical test in cases of prostatic carcinoma after castration as there is a temporary rise of the alkaline phosphatase followed by a drop to normal. Also, in cases with elevated alkaline phosphatase levels a temporary rise in titer after the administration of diethylstilbestrol then a drop to normal ranges proves the presence of prostatic carcinoma.

The authors show that prostatic carcinoma patients with an elevated serum acid phosphatase, but no evidence of metastases, have a poor prognosis. Their survival rate for three years is approximately 50 per cent less than in those prostatic carcinoma patients who have a normal serum acid phosphatase on the first admission. Surprisingly enough, the patients with known metastatic carcinoma of the prostate but a normal serum phosphatase exhibit as good or better response to therapy. This is unexplained since this situation has been theoretically attributed to anaplastic changes in the carcinoma preventing the elaboration of the enzyme. Thirty-five per cent of the patients fell in this group.—*T. D. Allison, M.D.*

Colby, Fletcher H., and Kerr, Walter S., Jr. Carcinoma of the bladder; an evaluation of total cystectomy and other methods of treatment. *New England J. Med.*, April 5, 1951, *244*, 504–506.

In order to evaluate the results of total cystectomy and to determine the relative value of total cystectomy to less radical methods, the authors present their results with total cystectomy in 103 cases performed at Massachusetts General Hospital from 1934 to 1950. Analysis of these cases disclosed that there was an overall postoperative mortality of 17 per cent. Of the 86 survivors, 63 (73 per cent) have died since the operation—54 of cancer and the others of sepsis

or uremia. Of the 103 patients, 23 are alive; 2 have recurrent disease. In 60 of the 103 cases operation was performed in the years 1944 to 1949. In this series, there has been a 10 per cent postoperative mortality, 68 per cent died approximately fifteen months following operation and 15 per cent are living without evidence of disease.

The authors also reviewed the results of treatment of all types in 700 cases of bladder carcinoma treated between 1934 and 1950. They felt that muscle wall penetration was a factor of more significance than tumor size, type or location. Of these 700 cases, 137 have microscopic studies satisfactory enough to show presence or absence of muscle wall invasion. Analysis of the 137 cases shows the following five year survival rates:

No cystectomy (100 cases):
- (a) muscle invasion—11 per cent survival of 82 cases.
- (b) no invasion—100 per cent survival of 18 cases.

Cystectomy (37 cases):
- (a) muscle invasion—8 per cent survival of 25 cases.
- (b) no invasion—16 per cent survival of 12 cases.

All forms of treatment (137 cases):
- (a) muscle invasion—10 per cent survival of 107 cases.
- (b) no invasion—66 per cent survival of 30 cases.

The figures would lead one to believe that total cystectomy is a less satisfactory mode of therapy in urinary bladder carcinoma, than other methods used.—*I. R. Berger, M.D.*

Nervous System

Cowie, Thomas N. Diastematomyelia with vertebral column defects; observations on its radiological diagnosis. *Brit. J. Radiol.*, March, 1951, *24*, 156–160.

Diastematomyelia is a rare congenital malformation in which the spinal cord is at some level divided into two parts. The case of a seventeen year old boy who was followed for five years before operation and who had been studied by myelography is described in detail. In this case there were many associated malformations of the spine and cord.

The most plausible explanation of the development of diastematomyelia is that it represents an incipient form of twinning, with the duplication of the cord the only well developed duplication persisting. This would account for the presence of complete meninges and complete sets of nerve tracts in each of the two tubes at the level of the deformity. The change in the cord is usually short and may be associated with bone changes. One of the commonest of these is the presence of an osseous or osteochondromatous process separating the two cords. Other changes which may be present are spinae bifidae, hemivertebrae, increased interpedicular distance and fusion of the vertebral bodies or laminae. The most important finding from a clinical viewpoint is the presence of a bony spicule near the midline, as symptoms, if they occur, are usually due to traction or pressure of the cord on this. Adolescence is the period of greatest disproportionate growth of the spine and cord and is thus the common time of onset of symptoms. Removal of the bone is adequate treatment.

The condition may be suspected after roentgenography, and demonstration of the midline bony spicule may be very important. Myelography may show widening of the opaque column, splitting into two columns, or a unilateral defect due to lack of filling of one part of the divided or duplicated cord. In view of the last possibility, differentiation from an intraspinal tumor is to be considered. Some of the bone changes may accompany a dermoid, but demonstration of a bony spicule is almost pathognomonic. —*E. F. Lang, M.D.*

Skeletal System

Saldanha, Aleu. Radiodiagnóstico das affecções endócrinas. (Roentgen diagnosis of endocrine affections.) *Cadern. cient.*, March, 1951, *2*, 664–698.

The roentgen diagnosis of endocrine affections is based on direct and indirect signs.

The direct signs are of relatively little significance because most of the glands are not visible on the roentgenogram. Direct evidence of glandular changes is as a rule only obtainable in the thymus and in the thyroid.

The indirect signs available for the diagnosis of endocrine disorders are found in the bone tissue, in the cartilage and in the connective tissue. The most important roentgen changes are seen in the osseous tissue, where they are manifested by alterations in growth, tissue differentiation and mineralization. Changes in the bone growth are influenced by the pituitary, the thymus and the sex glands, and may result in gigantism, acromegaly, dwarfism, etc. Hyper-mineralization or hypo-mineralization of the bones may be partly due to disturbances in the function of the thyroid, the adrenals, the pituitary and especially the parathyroids. The close relationship of diseases of the pituitary to changes in the sella turcica and possibly also to fibrous polyostotic dysplasia and Paget's disease is also discussed. Alterations in the cartilage of the joints have been attributed to hormonal influence. The roentgen diagnosis of changes in the connective tissue has so far little developed but the author hopes that further progress in this respect can be made by the study of the "absorption shadows" obtained by roentgen visualization of the connective tissue spaces. Acromegaly, Simmons' cachexia, Addison's disease

and myxedema are treated in detail.—*E. A. Schmidt, M.D.*

Gribetz, Donald, Silverman, Samuel H., and Sobel, Albert E. Vitamin A poisoning. *Pediatrics*, March, 1951, *7*, 372–385.

The literature has contained reports of vitamin A poisoning in animals since the late 1920's. The first case of vitamin A poisoning in a child was recorded in 1944. The authors tabulate the 14 cases which have been presented in the literature to date and report in detail 2 patient seen by them, in only 1 of whom was the diagnosis confirmed by laboratory studies.

The authors list the differential diagnostic points in hypervitaminosis A as:

1. Onset after the first year of life.
2. Presenting symptoms of irritability, anorexia, loss of hair, pruritus, painful soft tissue swellings, and tender extremities.
3. Thickened cortices of the long bones, especially the ulnae.
4. History of excessive vitamin A intake and a high plasma vitamin A level.
5. Rapid subsidence of symptoms when vitamin A is discontinued.

Differential diagnosis must include infantile cortical hyperostosis, which has its onset at an earlier age, is usually accompanied by fever, and in which the mandible is always involved. Clinical and serological studies will rule out the periostitis of congenital syphilis. The symptoms and signs may suggest leukemia which can be differentiated by transverse lines of lessened densities in the metaphyses of the long bones, osteolysis, and osteosclerosis. The roentgen changes in the metaphyses of rickets and scurvy should clearly differentiate these two diseases. The clinical picture of vitamin D poisoning differs markedly from that of A poisoning. —*R. M. Harvey, M.D.*

Pedersen, Herbert E., and McCarroll, H. R. Vitamin-resistant rickets. *J. Bone & Joint Surg.*, Jan., 1951, *33-A*, 203–220.

In crippled children's clinics, it has long been known that some cases of infantile rickets do not respond to the usual treatment with vitamin D but will respond to larger doses. This paper reports an investigation of 25 such cases, all of which had a history of rickets beginning in infancy. Each had been treated with large doses of vitamin D, but, in spite of this, florid rickets was still demonstrable by roentgenograms. This original treatment has usually consisted of 20 to 75 drops of cod-liver oil concentrate daily, or cod-liver oil fortified with percomorph oil, one teaspoon three or four times daily. None of the 25 children had any evidence of an abnormal dietary history or of gastrointestinal disease, and all had several normal urinary analyses and blood counts. In each instance, however, the presence and persistence of deformities necessitated one or more osteotomies in the lower extremities.

Several striking features were revealed in the examination of these patients. They presented the usual signs of active rickets, such as enlargements of all the palpable epiphyses, Harrison's groove, rachitic rosary and frontal bossing. In addition, there were certain features in all which had presumably resulted from the long-standing florid rickets. The most marked of these was short stature which results primarily from the lack of growth, varying with the severity of the disease, in the lower extremities. This feature was especially striking in the adult patients. Of the 10 adult patients examined, the height of 1 was found to be 5 feet, $5\frac{3}{4}$ inches, and of another to be 5 feet, $\frac{1}{4}$ inch, while the others were below 5 feet in height. Another noticeable feature was the presence of severe deformities in the lower extremities, bow legs, knock knees, or the "tackle deformity" which is a bow on one side and knock knee on the other. It is characteristic of these deformities that they tend to recur after early correction by osteotomies.

Follow-up examination of adults proved that late recurrences may occur. Ligamentous instability about the joints may be present, seen most commonly at the knee. The patients with this instability frequently complain of pain on moderate exertion and have occasional episodes of severe pain. Also associated with the deformities is a characteristic waddling gait, due to a fairly marked coxa vara. Deformities found in the skull are an increased anteroposterior diameter with frontal bossing and possibly an external occipital protuberance. A typical saddle nose may be present.

The roentgenographic evidence of such severe rickets may be classified under three headings: changes in the architecture of the bone, characteristic alterations of the epiphyseal structures, and deformities. In the cancellous bone of metaphyseal areas, the trabeculae are coarser, broader, and more widely spread than usual. The epiphyseal lines are much wider than usual. On the metaphyseal side of the epiphyseal line, the zone of calcification may be even and abrupt, but the usual finding is one of irregular calcification, presenting a "woolly" or fuzzy appearance. It was found that a constant roentgenographic improvement in the appearance of the epiphyseal lines occurred following plaster immobilization. It was noted that, of all the epiphyses, improvement was the easiest to see in the upper tibial epiphyses, whether it was the result of plaster immobilization or vitamin therapy.

The results of the laboratory studies showed in every instance the changes characteristic of rickets, with no other abnormalities demonstrable. The most important blood studies were the determinations of serum calcium, serum phosphorus and serum alkaline phosphatase.

Two plans of treatment were used by the authors. The first dealt with patients who were treated vigorously in an effort to determine the maximum safe response and to elevate the serum phosphorus levels to normal. When the maximum response, or toxicity, had been elicited, treatment was discontinued to study the pattern of regression. The second plan was developed for the treatment of out-patients who were treated with smaller doses of vitamins and checked at monthly intervals by means of urinalyses, blood chemistry determinations and roentgenograms. The response to treatment was extremely variable and served to emphasize the statement that each patient is an individual problem. On adequate dosage with vitamin D the serum inorganic phosphorus and urinary calcium rise, and the alkaline phosphatase gradually declines. Changes in urinary calcium and serum inorganic phosphorus were seen within a week, while roentgenographic changes did not appear for three to four weeks. The clinical signs of toxicity were: anorexia, nausea, vomiting, weight loss, occasionally hematuria and rarely oliguria or anuria associated with nephrocalcinosis. Toxicity, while on massive doses of vitamin D, was not seen in the absence of definite hypercalcemia. The urine during toxic states contained many calcium casts.

Seven patients in the series were treated with massive doses of vitamins during plaster immobilization following osteotomies. All thus treated showed very marked improvement at the epiphyseal lines, but all developed severe anorexia, nausea, vomiting and weight loss.

The authors feel that the disease is far more common than has been previously reported, and actually represents the most common cause of dwarfism. It has a strong familial tendency. It may be present in varying degrees of severity and the exact amount of vitamin therapy required for each individual case can only be determined by the trial and error method. It becomes less severe after epiphyseal closure, but some adults may require continued vitamin therapy.—*R. S. Bromer, M.D.*

Odell, Richard T., and Leydig, Stanley M. The conservative treatment of fractures in children. *Surg., Gynec. & Obst.*, Jan., 1951, *92*, 69–74.

A report on the conservative treatment of fractures in children seems timely in our present era of open reduction and internal fixation. These methods are definitely of value in selected cases but are usually not necessary in the management of fractures in children. In fact they are apt to do irreparable harm.

1. Fractures of the clavicle usually re-establish normal contour although the fragments may be overriding and not in apposition.

2. Fractures of the upper end of the humerus are easily managed in a hanging cast.

3. Supracondylar fractures of the humerus are sometimes troublesome. However, the result of open operation with the attendant capsular adhesions and stiffness which may follow is often more undesirable than a poor closed reduction.

4. Avulsion fractures of the external condyle and internal epicondyle of the humerus are occasional of exceptions to the rule of conservative treatment and may require open reduction. If the fragment of the internal epicondyle is displaced into the joint or if the lateral condyle is rotated outward and downward, open reduction is necessary.

5. Fractures of the forearm are among the most common fractures seen in children and accurate reduction is frequently very difficult to obtain and maintain. However, open reduction is rarely indicated inasmuch as infection and non-union are frequent complications of open reduction in children.

6. Fractures of the head of the radius are not uncommon and open reduction is necessary if the head is displaced. This is important because the length of the radius will not keep pace with the ulna if the head is not functioning.

7. Isolated fractures of the lower end of the radius may be extremely difficult to reduce but a poor closed reduction is to be preferred to open reduction because normal function without deformity results in most fractures (in children) if the forces of nature are not interfered with by repeated manipulation or open operation.

In their conclusions the authors reiterate the fact that prolonged observation of inaccurately reduced fragments is much superior to surgery in the child. Open operation should be reserved for: (1) replacement of fractured head of radius, (2) certain displaced fractures of the internal epicondyle and external condyle of the humerus, (3) fractures of the neck of the femur, 4) fractures of the olecranon or patella with wide separation of the fragments (rare), and (5) irreducible separation of the distal epiphysis of the femur.—*Mary Frances Vastine, M.D.*

Massie, William K., and Howorth, M. Beckett. Congenital dislocation of the hip. Part II. Results of open reduction as seen in early adult period. *J. Bone & Joint Surg.*, Jan., 1951, *33-A*, 171–190.

In this paper the authors report the results after open reduction of 58 congenital dislocations of the hip. The optimum roentgenographic grade, according to their previously reported method of grading, was attained two years after reduction in 66 per cent of the hips and by puberty in 85 per cent. Hips followed roentgenographically in children between the ages of five and eight years showed definite trends toward the eventual adult result, a fact which is of practical value in determining further treatment. Vascular changes were seen in 41 per cent of the femoral heads In 81 per cent of the hips so involved,

the roentgenographic rating was below 70 per cent of the normal.

The authors again propose that an initial capsular relaxation is the primary abnormality in congenital dislocation of the hip. Subluxation and dislocation are the result of the mechanical forces applied to the hip with a relaxed capsule. The acetabular changes are secondary.

Any degree of post-reduction subluxation seriously jeopardizes the development of a normal adult hip. Increase of the subluxation ensures an unsatisfactory result. On the other hand, the obtaining and maintaining of perfect reduction ensure an excellent result if no vascular change affects the epiphysis.

The follow-up period of study was eighteen years. The paper is illustrated with numerous roentgenograms of serial follow-up study of the reported cases.—*R. S. Bromer, M.D.*

Massie, William K., and Howorth, M. Beckett. Congenital dislocation of the hip. Part III. Pathogenesis. *J. Bone & Joint Surg.*, Jan., 1951, *33-A*, 190–198.

This study is based on 300 congenital dislocations of the hip reduced by open operation, 15 fetal hips dissected between the tenth week and tenth month of fetal life and the study of 58 congenital dislocations of the hip reduced by open operation in which the patients were followed to adult life. There is very little knowledge of exactly what happens in congenital dislocation of the hip before birth, and the knowledge of the embryological development of the normal hip is incomplete. The authors' studies of 15 fetal specimens indicated that the hip is well formed by the tenth fetal week, when the acetabulum, femoral head and neck and capsule are well developed. The normal embryological and fetal development of the hip, therefore, would tend to ensure a stable joint. The most widely accepted theory of the cause of the dislocation is that of primary dysplasia of the acetabulum with high obliquity which provides inadequate support for the femoral head. There are, however, many contradictions to the theory of primary acetabular dysplasia. The authors have seen cases which show that dislocation of the hip sometimes occurs before birth.

The cartilage of the superior margin of the acetabulum and the glenoidal labrum is quite plastic in the fetus and infant. As soon as subluxation occurs, the pressure of the femoral head against the glenoidal labrum and the superior margin of the acetabulum depresses them and a groove or fossa begins to form, resulting in the oblique acetabular roof. Unless pressure is relieved, the obliquity increases and when ossification occurs, at about five years of age, the obliquity is permanent. Continued pressure of the head against the superior margin and filling in of the base of the acetabulum cause the acetabulum to become elongated and shallow. Complete dislocation above the acetabular margin, with no pressure against the margin, results in a small acetabulum due to filling in, but obliquity of the roof is relatively slight or absent.

The authors conclude from their observations that, if the femoral head is permitted to dislocate completely in the early months of life, there is no pressure deformity of the acetabular brim, and therefore the roof obliquity remains essentially as it had been at the time of dislocation. In time the floor of the acetabulum thickens as the results of the pressure of the femoral head and this may gradually increase the obliquity by filling from within. However, it has been repeatedly demonstrated that, if the head can be adequately reduced and maintained at this early age, the acetabular roof develops rapidly to a normal appearance.

Since the one constant pathological finding in congenital dislocation or subluxation of the hip is elongation or relaxation of the capsule, this is considered to be the primary etiological factor. The cause of the elongated capsule is unknown. It is possibly of genetic origin, possibly mechanical, possibly hormonal, or due to some nutritional deficiency as yet unknown.

The authors conclude that if capsular relaxation is the primary etiological factor, and if it is assumed that all reparative processes of the hip joint are normal and are dependent on only one condition, namely, obtaining and maintaining a normal head-acetabulum relationship, then the problems of the condition seem greatly simplified and almost wholly within the surgeon's control. If, at the same time, vascular changes in the capital epiphysis can be prevented or adequately treated, the results of early treatment of congenital dislocation of the hip should be excellent even by the highest standards.—*R. S. Bromer, M.D.*

WILDER PENFIELD

Caldwell Lecturer, 1951